BULLETIN

OF

ENTOMOLOGICAL RESEARCH

ISSUED BY THE IMPERIAL
BUREAU OF ENTOMOLOGY.

EDITOR: THE DIRECTOR.

VOL. VI.

LONDON:

SOLD BY

DULAU & Co., Ltd., 37, SOHO SQUARE, W.

1915-1916.

IMPERIAL BUREAU OF ENTOMOLOGY.

Honorary Committee of Management.

Head Office.—British Museum (Natural History), Cromwell Road, London, S.W.

Publication Office.—27, Elvaston Place, London, S.W.

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JUNE, 1915.

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IMPERIAL BUREAU OF ENTOMOLOGY.

HONORARY COMMITTEE OF MANAGEMENT.

POTATO SPRAYING AND DUSTING IN NEW JERSEY, U.S.A.

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Board of Agriculture Scholar and Honorary Research Fellow, the Department of Agricultural Entomology, Victoria University, Manchester.

(Plates I–III.)

Introduction.

In the beginning of last year, in terms of the conditions which required my studying abroad as a scholar of the Board of Agriculture and Fisheries, I proceeded to America in order to carry out research work under the auspices of the Entomological Department attached to the Agricultural Experiment Station of New Jersey. During a period extending from early spring until late autumn I had the opportunity of supervising and directing the field experiments concerned with the spraying and dusting of the potato crop undertaken by this Station. The purpose of the work was of a two-fold nature :—(1) to determine in a large practical way the relative value of spraying and dusting mixtures in attaining a maximum yield of tubers through control of injurious insects and plant diseases and through growth stimulus imparted to the foliage ; (2) to devise a satisfactory method of controlling the potato flea-beetle (*Epitrix cucumeris*, Harr.).

The work was of a co-operative nature, on the one hand between the Experiment Station and potato-growers, and on the other hand between the Experiment Station and certain chemical manufacturers. The growers supplied the facilities for carrying out the tests on their crops, and also carefully performed the necessary work in connection with them. The commercial firms very generously provided the material required in the various treatments, except in the case of Bordeaux mixture, for which the copper sulphate and stone lime had to be purchased.

The results of the work apply more particularly to the State of New Jersey, U.S.A., and generally to the north-eastern States of that country. In my opinion there is no valid reason why experiments of a like nature should not be undertaken in Great Britain. A perusal of the paper will serve to indicate how very much alive the American farmer is to the advantages of adopting new methods likely to benefit him financially ; and secondly, it may stimulate the energies of those willing to learn a lesson in progressive measures. The orchardist or agriculturist in America is more fortunate than his British cousin in that he can always, when in doubt as to some specific question relating to good culture, consult the experts attached to the State Agricultural Experiment Stations, who have made it their special province to investigate local agricultural and orchard problems. And further, these same stations, by means of their large and well-equipped staffs, are enabled to arrange most useful and educative propaganda. This work embraces a wide range of subjects pertaining to the successful cultivation of crops. They are also always ready to

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co-operate with the farmer in the carrying out of practical demonstrations. In my opinion the adoption of similar experimental methods in this country, suitable to local needs, would serve the best interests of our agricultural communities.

In the course of my duties I had the opportunity of deriving from many farmers, well versed in the most up-to-date methods of agriculture, their personal experiences in the matter of spraying, and the general trend of their ideas has been hitherto essentially antagonistic to the adoption of spraying with Bordeaux mixtures. In the first place, they argued that the operation entailed more trouble than it was thought to be worth; and secondly, it failed to prove of any advantage when the final profits came to be reckoned up. This seemed interesting in view of what was the experience of others elsewhere, and I concluded that either some climatic or soil factor, or perhaps some method of agriculture, counteracted or obscured the otherwise admittedly beneficial effect of the insecticide, or that there was some carelessness in the manner of its preparation or application.

Three places were secured for the accomplishment of the work, namely, at Freehold, Robbinsville and Elmer, in the counties of Monmouth, Mercer and Salem respectively, —districts which may be considered fairly representative of the potato-growing sections of the State of New Jersey. At all three places satisfactory returns showed the benefits to be obtained from the employment of Bordeaux mixture. At Freehold, however, the increase in yield as compared with the other treatments, hereafter discussed, was not so marked. Indeed, so little was the difference in any of the treatments and so uniform the yield that I am inclined to look for the reason of apparent failure to the fact that peculiar methods of culture may have influenced the final result. Here the surface soil is a sandy loam, containing a large amount of potash (2·5 per cent.), underlaid by a greenish yellow, sticky marl, and on this particular farm a system of deep-ploughing has been adopted, enriching the top soil with the most satisfactory results. In addition, the farmer is in the habit of feeding his soil with abundant supplies of farmyard manure, as well as commercial fertiliser, which may secure such strong and vigorous plants that the effect of the Bordeaux mixture is entirely lost. In other words, what I would tentatively suggest in view of the evidence obtained, is, that under certain conditions with which we are not as yet entirely familiar, the potato foliage may arrive at an optimum of vigour beyond which it may fail to be stimulated. At Freehold then, the slightly increased yields on the home-made Bordeaux, as compared with those obtained on the sulphur and proprietary Bordeaux plots, may be justly ascribed to its more efficient control of the flea-beetle (*Epitrix cucumeris*, Harr.), which, in dry seasons like that just past, levies, in New Jersey at least, a higher tax on the crop than any of its vegetable parasites. Indeed, we have here a reason for the comparatively poor showing of Bordeaux mixture in New Jersey. One dry season follows another with such regularity that the Early (*Macrosporium solani*, E. & M.) and Late Blights (*Phytophthora infestans*, De Bary), which exact such a heavy toll in the more northern States, here do serious damage only in an occasional wet season, when the conditions are favourable to the germination of the spores. Therefore it is only natural to assume that Bordeaux mixture, which is specific against these potato blights, will be more likely to demonstrate its capabilities in seasons favourable to their development, and this indeed has been the experience of several New Jersey farmers.

The use of sulphur in these experiments marks an innovation in the application of this material as a fungicide of potato-leaf diseases, in this State at least. In Europe, especially Southern France, and in Algeria, sulphur has been extensively used in combating *Oidium* and other fungous diseases of the grape vine with most encouraging results. Of the various forms employed ground sulphur has shown itself superior to sublimed, wind-blown and precipitated sulphur in its anticrypto-gamic properties. This is accounted for by the fact that it is said to contain neither sulphuric nor sulphurous acids which burn the leaves under the influences of great heat. Again the finely divided condition of ground sulphur is a factor of importance bearing on its fungicidal capacity, to which may be added the further advantage of its lower cost of production. Neutral mixings, according to Bourcart,* have a much more gentle action on the leaves, therefore mixtures of sulphur with gypsum and lime are generally employed, which, moreover, favour adherence in rainy weather. According to this same author (*loc. cit.* p. 46) sulphur has also a direct action on the grape vine, which it renders more vigorous. That this is probably true also of potato foliage under certain circumstances is shown by the results obtained at Elmer on the blocks dusted with a mixture of sulphur and lead arsenate. These yielded 21 bushels per acre more potatoes than those treated with arsenate of lead alone. This was, however, but a third of the increase derived from the use of Bordeaux and lead arsenate mixture.

A series of experiments carried out by Bourcart (*loc. cit.* p. 46) showed that sulphur was effective as a fungicide between the temperatures of 77°–122° F., not in virtue of the supposed generation of sulphur dioxide or sulphuretted hydrogen, but by reason of its own vapours. But it was my experience that applications of sulphur made in the heat of summer (95° F.) may cause injury to the leaves, which are burned under the action of the sun.

The comparative aspect which this year's experiments are intended to bear out must not be lost sight of, and the differences in yields obtained on the differently treated plots are worthy of strict attention. Besides the fact that the home-made Bordeaux mixture gave the best return as regards yields in all three experiments, it also proved to be the most economical in application, excepting the lead arsenate used on the control plots at Freehold and Elmer and intended only to check the ravages of the Colorado and flea-beetles.

The experimenters at Geneva, New York, have also come to the conclusion that there are several factors which might have an important influence on the results. Amongst those are mentioned differences of locality and soils†. The averages for the ten-year experiments at Geneva and Riverhead reveal the fact that the average increase for sprayed potatoes per acre at the former is more than double the increase at the latter. At Geneva the soil is rather a heavy clay loam, at Riverhead a sandy loam, which is interesting in view of what has been said about the experiments at Freehold, New Jersey. Sheltered rather than exposed conditions give better results, and in the final reckoning up the fertility of the land and the variety of the potato are factors of no mean importance. But probably, as the author remarks, most attention must be paid to thoroughness in spraying.

* Bourcart (E.).—Insecticides, Fungicides and Weed-Killers. London, 1913. p. 45.

† Stewart (F. C.).—Bull. 290, N.Y. Agr. Exper. Sta., 1907.

Plan of the Experiments and Arrangement of Plots.

The idea was to carry out the experiments on as large a scale as possible, so that the objection which is often advanced, of the futility of forming correct conclusions from the yields of rows treated singly, would not hold good. Therefore at Robbinsville and Elmer the fields were divided up into plots of 20 rows, and six of these plots formed a series. Within the series each alternate plot was a control, treated at Robbinsville with a mixture of zinc arsenite (active ingredient, $Zn_3(AsO_3)_2$, not less than 90%) and gypsum calculated to repress the activities of the flea-beetle and Colorado beetle, and at Elmer arsenate of lead (containing not less than 9·8% total metallic arsenic, of which not more than 0·48% is water soluble, equivalent to 0·75% arsenic oxide) was employed for the same purpose. The other treatments in the block or series varied, viz. :—at Elmer, Bordeaux mixture combined with arsenate of lead, Kil-Tone, and a mixture of sulphur and lead arsenate; at Robbinsville, Bordeaux combined with lead arsenate, Vreeland's "Electro" Bordo-Lead, and a mixture of sulphur and zinc arsenite. At Robbinsville, where the field contained slightly more than twenty-four acres, this series of plots was repeated four times, so that any inconsistencies due to the nature of the soil might be eliminated as far as possible. At Elmer, where there was approximately ten acres, there was only space for a single repeat.

The arrangement at Freehold was slightly different, the field of about twenty-four acres being divided up into blocks of but eight rows, so that many more control plots could be inserted. Then again every alternate plot was a control, the other plots in the series of six being treated with Bordeaux mixture and lead arsenate, a mixture of sulphur, lead arsenate and gypsum, and Ansbacher's Bordeaux. It will be noted that at each place a different proprietary fungicide was used.

Methods of the Experiments.

In applying the wet preparations, two types of spraying machines were employed. At Elmer, the Watson Sprayer, made by the Field Force Pump Company of Elmira, New York, gave eminently satisfactory results (fig. 1).

The only objection that could be advanced was the fluctuation in the maintenance of the pressure from sixty to eighty pounds. It is desirable to aim at getting higher pressure, so that the spray-liquid may be delivered as a fine mist on the leaves. At Freehold and Robbinsville, the power spraying machine made by the Bateman Manufacturing Company of Grenloch, New Jersey, gave the requisite pressure of one hundred pounds, ensuring a uniform application of the fluid (Plate i). In all cases the nozzles were adjusted so that four rows could be covered at one time and were so arranged that they gave the "diamond" effect in their delivery of the spray, a fact of the utmost importance, seeing that it is necessary to cover the under as well as the upper surfaces of the leaves with the fungicide.

In applying the dust mixtures of sulphur combined with gypsum, arsenite of zinc and arsenate of lead, the Potato Duster (Plate ii), made by the Dust Sprayer Manufacturing Company of Kansas City, Missouri, was used. Here it is necessary to state that the original plan was not carried out in its entirety, and whereas it was intended to apply treatments III and IV (see Table I) as dry powders, so much

difficulty was experienced that eventually it was decided at Elmer and Freehold to apply the lead arsenate wet, at the rate of six pounds per one hundred gallons.

In all cases the application of the sulphur mixtures was successfully undertaken, except at Freehold, where no treatment was made for the first spraying, and for the second a mixture of hydrated lime and lead arsenate was used in dry form in the proportion of 69 lb. of the former to 31 lb. of the latter.

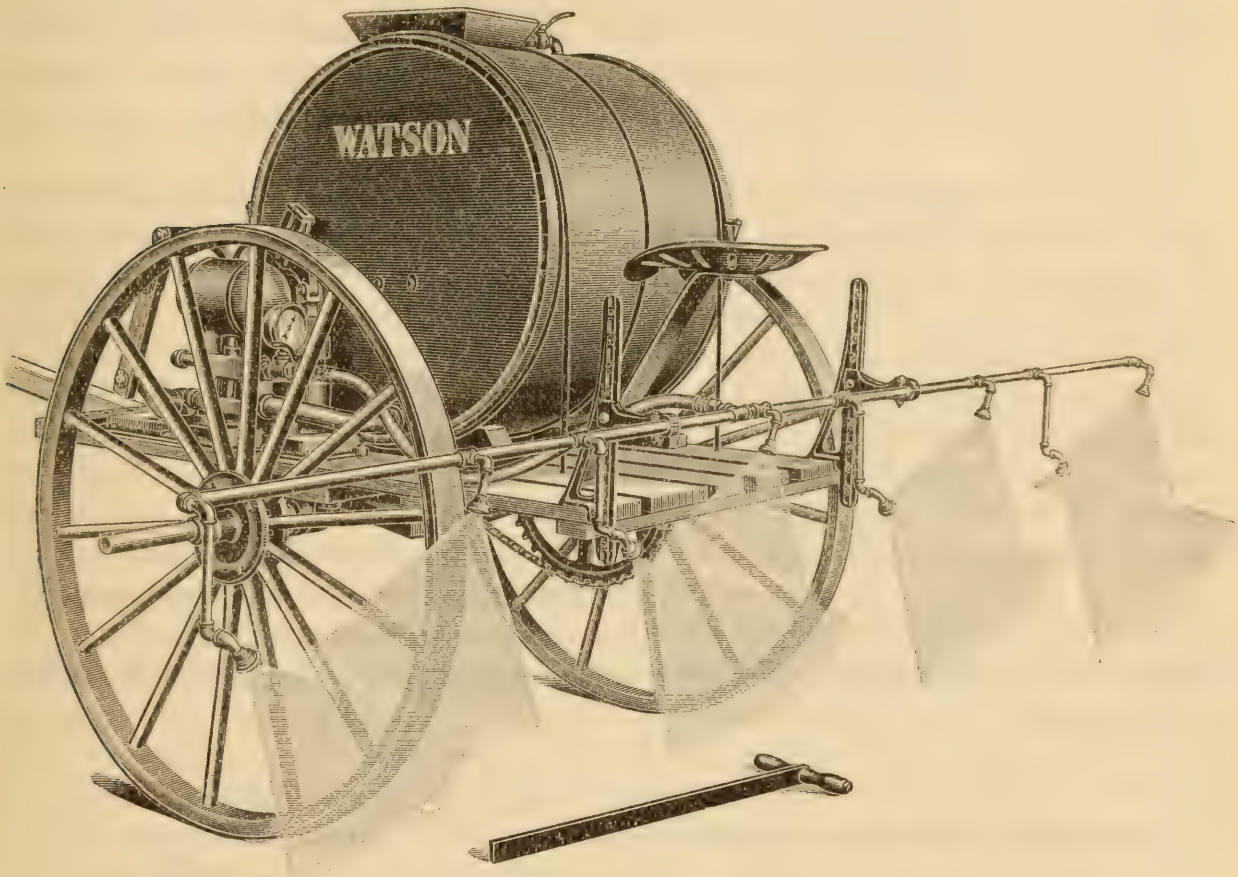

Fig. 1. The Watson Sprayer.

Comment must be made on the fact that the potato dusting machine did not give complete satisfaction, but this was partly due to the materials, which frequently cohered to such an extent within the delivery pipes that blocking ensued. It was for this reason mainly that the lead arsenate was applied wet; otherwise a great deal of valuable time would have been wasted. Even as it was, a lot of trouble was experienced in regulating the quantity of dust that was being applied, but finally, after making some adjustments, we were enabled to feed out the sulphur-gypsum-lead arsenate, the sulphur-zinc arsenite and the sulphur-lead arsenate mixtures in the required amounts of about 30–36 pounds per acre.

Directions for Spraying.

Most up-to-date farmers who find it necessary to use Bordeaux mixture are acquainted with its method of preparation, so that it seems superfluous to repeat it here. Suffice it to say that the formula of the mixture employed in our experiments

was the same in all three, namely 5–5–50, and to every 100 gallons of the mixture six pounds of arsenate of lead were added as a poison for the Colorado potato beetle (*Leptinotarsa decemlineata*) and the flea-beetle (*Epitrix cucumeris*). This poison served to control the ravages of these pests at Elmer and Freehold, but at Robbinsville zinc arsenite was tried, with what results will be hereafter set forth in the section on flea-beetle control.

In the case of the proprietary Bordeaux preparations, Ansbacher's* was applied at the rate of 20 pounds per 100 gallons, which sufficed to cover just about two acres. Vreeland's Electro Bordo-Lead† was applied at the rate of about 18 pounds per acre dissolved in 100 gallons, an intentionally, rather heavy application ; while 13 pounds of Kil-Tone,‡ of which 18 pounds were dissolved in 100 gallons, served to treat one acre at Elmer.

It was so arranged that an interval of 8 to 12 days should elapse between each treatment, this being considered the outside limit for safety, since the new shoots which are springing up run serious risk of damage both from insect destroyers and fungus parasites if a longer period is allowed to intervene between the applications. Assiduous attention to spraying and thoroughness of application are important factors for good results, and it has been shown by the experiments of the New York Agricultural Experiment Station § that the more sprayings one makes the greater are likely to be the yields, and therefore the profits. In New Jersey, the potato foliage begins to overlap in the rows about the end of June, making it difficult for the operator to drive a team into the field without injuring the plants. It is quite possible to have made four applications previous to this, but the foliage continues to grow for a month later. In cases where circumstances are favourable to the appearance of the late blight, it would be absolutely essential to make at least two further treatments before the foliage dies.

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* Analysis of Ansbacher's Bordeaux-Lead:—

Moisture	42%
Copper Hydrate ($Cu(OH)_2$)	6·36%
Lead Oxide ($Pb\,O$)	20·51%
Total Arsenic Oxide ($As_2\,O_5$)	9·19%
Inert ingredients by difference	5·91%
After drying.	
Copper Hydrate ($Cu(OH)_2$)	15·16%
Lead Oxide ($Pb\,O$)	48·85%
Total Arsenic Oxide ($As_2\,O_5$)	21·90%
Inert ingredients	14·09%
Arsenic Acid soluble in water	trace.

† Analysis of Vreeland's Electro Bordo-Lead:—

Dry Lead Arsenate	27·00—33·00%
Copper	1·65— 2·00%
Inert ingredients	64·67—71·08%
Water soluble arsenic, expressed as metallic ..	·107— ·117%

‡ Figures for Kil-Tone are not available.

§ Bull. 323, N.Y. Agric. Exper. Sta., Geneva, 1910, p. 323.

TABLE I.

Scheme of the Treatment.

LOCALITY.	TREATMENTS.			
	I.	II.	III.	IV.
Elmer	Bordeaux and Lead Arsenate. May 21–22.	Kil-Tone. June 1–2.	Sulphur and Lead Arsenate, (5–·5). June 10–11.	Lead Arsenate. June 24–25.
Freehold	Bordeaux and Lead Arsenate. May 21–22.	Ansbacher's Bordeaux-Lead. June 17–28.	Sulphur, Gypsum and Lead Arsenate (2–3–1). June 5–6.	Lead Arsenate. June 16–17.
Robbinsville ..	Bordeaux and Lead Arsenate. May 27–28.	Vreeland's Electro-Bordo-Lead. June 10–11.	Sulphur and Zinc Arsenite (5–1). June 23–25.	Gypsum and Zinc Arsenite (5–1). June 30.*

Discussion of the Individual Experiments.

At Elmer. From the middle of May until the middle of August there were eleven inches of rainfall, with periods of prolonged drought, during which there was quite a lot of " tip-burn," a physiological condition of the leaves for which no proper reason can be assigned. Probably it is a case of the plant suffering from mal-nutrition as a result of some climatic or atmospheric condition. We cannot say that drought is the only cause, because it has been observed to be prevalent during wet spells. On the 21st May, when the first application was made, the flea-beetle had already been at work for several days, although the foliage was not more than six inches high. The damage being done was considerable, and added to this there were large numbers of eggs of the Colorado beetle on the leaves, some of which had already hatched, betokening injury to come. The plan of the field was as follows :—

Series I.

Bordeaux Mixture and Arsenate of Lead.
Arsenate of Lead.
Kil-Tone.
Arsenate of Lead.
Sulphur and Lead Arsenate Mixture.
Arsenate of Lead.

* On this date an application of sulphur and zinc arsenite was made on the sulphur plots of the first and second series—there being four series in all at Robbinsville—and on sixteen rows of the third series when an accident rendered the machine useless and so no further spraying was done. At Robbinsville, therefore, with the exception of these plots mentioned, only three applications of the various treatments were made.

Series II.

Kil-Tone.
Arsenate of Lead.
Bordeaux Mixture and Arsenate of Lead.
Arsenate of Lead.
Sulphur and Lead Arsenate Mixture.
Arsenate of Lead.

As will be observed, the field was divided into two blocks in both of which there were six plots of twenty rows, each plot measuring 0·89 acre except, the last arsenate of lead plot, which had only fifteen rows and measured 0·68 acre.

On 2nd June the field was examined for flea-beetles. The numbers had been greatly reduced, but an adjacent field of potatoes, which had not been treated, was badly infested with this small pest. It would appear that the beetles had been repelled to this neighbouring field. On some of the plants a few Aphides, *Rhopalosiphum solani,* were observed at work, but not in sufficiently great numbers to cause uneasiness or to make it worth while to go to the expense and trouble of a special treatment. At this stage the Kil-Tone plots compared favourably with the others as regards insect control, and indeed, so far as observation could be trusted, this proprietary preparation seemed to give quite satisfactory results.

On 24th June a rather curious phenomenon was observed. The potato plants were now in blossom, but the flowers had died off quickly on all the plots except on the controls sprayed with arsenate of lead. What was the exact significance of this cannot be stated, but that there was no ultimate detrimental effect is shown by the yields, which were greater on all these plots than on the controls. On this date too there was a slight recrudescence of the flea-beetle, especially noticeable on the sulphur plots, but after the treatments had been applied they were effectively repelled. Perhaps their increase on these plots was due to the fact that the dust does not adhere to the foliage for such a long time as the wet sprays, and therefore more frequent applications would have to be made to maintain its efficiency.

On 7th July, in addition to *Epitrix cucumeris*, there was present in appreciable numbers another species of flea-beetle, *Epitrix fuscula*, Cr., which, according to Dr. Smith,* is supposed to be rarely found in New Jersey. The recurrence of the flea-beetle at this period led me to the belief that there is a second brood, if not a third, in this State, for after a decided diminution a second time there was an increase on 26th August on the late crops in the southern regions. These periods of great infestation alternating with periods of absence of attack are generally characteristic of multi-brooded species.

As regards fungous diseases, cases of early blight were very rare on the first crop, and late blight was not observed, but on the second crop, in August, early blight seemed to be rather general, appearing first when the plants were yet small.

During the early days of August the so-called "old-fashioned potato beetle," *Epicauta vittata,* appeared suddenly in the fields of South Jersey, stripping the vines of all leaves that were yet green. This was considered peculiar, in view of the fact

*Smith (J. B.).—Ann. Rept. New Jersey State Museum ; Insects. Trenton, 1910, p. 352.

that not a single specimen was observed in the northern parts of the State. Its occurrence in the south can be associated with the greater prevalence of grasshoppers, on the eggs of which this Meloïd beetle feeds in its larval stages.

Throughout the season the plots sprayed with Bordeaux mixture gave every promise of large yields; the plants had a healthy deep green colour, while they retained their vigour at the end of the season for almost ten days longer than those in the other plots (Plate iii, figs. 1 and 2). From an examination made on 24th July, the order of value of the various treatments was as follows :

1. Bordeaux mixture and arsenate of lead.
2. Sulphur and lead arsenate mixture.
3. Kil-Tone.
4. Lead arsenate.

That this order, as determined by the appearance of the foliage, had some significance, can be judged from the yields obtained when the potatoes were dug on 10th August.

TABLE II.

Yield of Tubers (Firsts and Seconds) at Elmer.

Nature of Application.	Yield in bushels per acre. Series I.		Series II.		Average of the 2 series.	
	1sts.	2nds.	1sts.	2nds.	1sts.	2nds.
Bordeaux and Lead Arsenate	201·5	51·35	254·15	44·2	227·82	47·78
Lead Arsenate (Control) ..	102·7	30·55	199·2	39·9	180·55	32·175
	180·8	41·9	213·85	21·4		
	154.7	34·7	232·05	24·6		
Sulphur and Lead Arsenate ..	187·4	34·7	218·40	26·6	202·9	30·6
Kil-Tone	161·84	38·35	191·3	37·5	176·58	37·92

Avg. gain in bushels per acre of firsts on Bordeaux plots over control, 47·27
Avg. gain in bushels per acre of firsts on Bordeaux plots over sulphur, 24·92
Avg. gain in bushels per acre of firsts on Bordeaux plots over Kil-Tone, 51·24

Avg. gain in bushels per acre of seconds on Bordeaux plots over control, 15·60
Avg. gain in bushels per acre of seconds on Bordeaux plots over sulphur, 17·18
Avg. gain in bushels per acre of seconds on Bordeaux plots over Kil-Tone, 9·86

Avg. gain in bushels per acre of sulphur and lead arsenate plots over control (firsts and seconds) .. .. 20·77

Avg. gain of sulphur and lead arsenate plots over Kil-Tone .. .. 19·00

Two years previously the same field had been planted in potatoes. Then followed a rotation of grass, clover and timothy, which was mowed in the summer following for hay. Late in the autumn it underwent ploughing, the soil being turned up to a depth of eight inches, and then in the spring it was worked with a Clark cut-away harrow. Fertiliser of the formula 4–8–10 was administered at the time of seed-planting at the rate of about a ton and a quarter to the acre.

At Freehold. From 21st June until the end of July, representing the most important period of growth of the foliage, there was only 4·8 inches of rain, and although the weather was excessively dry and warm at times, the plants made such headway that the profuse foliage of the " Giant " variety was meeting in the rows almost at the time of the fourth application of the treatments on 16th June. Here there was a fair amount of "tip-burn," and also some *Fusarium oxysporum*, the fungus of dry rot. There was no late blight and only an infinitesimal amount of early blight which appeared first late in the season, about 20th July. Practically none was to be found on the plots sprayed with Bordeaux mixture or with the Ansbacher preparation, but the lead arsenate and sulphur dust plots had a fair amount. However, not a great deal of damage was done as the foliage was already dying.

There were eight series of six plots at Freehold with one smaller series of but two plots. The area of the field was 24·57 acres and each plot had but eight rows. At no time throughout the season could the eye observe any difference in the foliage of the various plots that could be supposed to be due to difference of treatment, and as the probable reasons for this remarkable fact have already been detailed (page 2), it will not be necessary to take up the discussion again at this point.

The same notable fluctuation in the presence of the flea-beetle was likewise observed here as at Elmer and also at Robbinsville, lending further support to my belief that there are three broods of this pest in New Jersey. Johannsen* is quite emphatic in his assertion that there is but a single brood in the State of Maine, or at most a partial second, and quotes Sirrine's experience in New York State as supporting his statement. This however does not prove that single-broodedness is a universal characteristic of the species.

The yields as obtained at Freehold are set forth in the table, and a glance at the last column will readily show how little advantage accrued from the spraying or dusting. Still, something was achieved, in that the home-made Bordeaux mixture vindicated itself, if ever so little, here as at Elmer ; but on this occasion the lead arsenate control plots came out somewhat ahead of those treated with the proprietary Ansbacher preparation. Perhaps the results would have worked out somewhat differently had it been possible to apply the sulphur-gypsum-lead arsenate in a more satisfactory fashion. Again, the non-application of this material during the first and second treatments also militated against a true comparison of the results.

At Freehold the variety most grown is the " Giant," and the tubers are sold mixed, there being no separation into firsts and seconds, or marketables and culls.

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*Johannsen (O. A.).—Potato Flea-Beetle. Bull. 211, Maine Agr. Exper. Sta., 1913, pp. 39–40.

TABLE III.

Yields of Potatoes at Freehold.

Nature of Application.	Yield in Bushels per acre.									Average of the nine plots.
	Series I.	Series II.	Series III.	Series IV.	Series V.	Series VI.	Series VII.	Series VIII.	Series IX.	
Bordeaux and Lead Arsenate ..	309·4	279·2	287·2	291·4	279·9	288·75	275	279·58	254·16	286·06
Lead Arsenate (Control)	275·0	291·6	272·1	310·88	275·0	288·75	284·16	275·0	275·0	283·38
	324·0	290·7	281·7	292·1	275·0	284·16	288·75	265·8	—	
	275·0	286·8	293·7	280·5	275·0	279·58	288·75	265·8	—	
Sulphur, Gypsum and Lead Arsenate ..	303·4	291·1	275·0	290·8	265·5	270·14	252·08	275·0	—	277·87
Ansbacher's Bordeaux-Lead	233·	290·2	294·1	286·7	280·0	279·58	265·8	270·4	—	281·62

Avg. gain in bushels per acre of Bordeaux plots over control .. .. 2·68
Avg. gain in bushels per acre of Bordeaux plots over sulphur .. .. 8·19
Avg. gain in bushels per acre of Bordeaux plots over Ansbacher .. .. 4·44
Avg- decrease in bushels per acre of sulphur plots below control .. .. 5·51
Avg. decrease in bushels per acre of Ansbacher plots below control .. .. 1·76

It is of interest to note the general uniformity of the figures, there being very little variation in yield in the plots of each individual series, except perhaps in series I where the Bordeaux plot outyielded the average of the control plots by 18 bushels per acre. In this series too the sulphur-gypsum-lead arsenate plot also gave an increase of twelve bushels per acre over the control plots, while the plot sprayed with Ansbacher's Bordeaux and lead arsenate lagged behind the control plots to the extent of 14·5 bushels. But this only serves to show how little confidence can be placed in results when the figures of only a single series are considered. The truth can only be ascertained by averaging up a number of series.

The field at Freehold, as regards previous cultivation, presented three distinct sections. Six acres had been planted in potatoes for four years, and each year wheat and crimson clover had been ploughed under as a green manure. Nine acres had been planted with maize during the two previous years and cow-peas sown out amongst the maize. Here there had been a rotation of wheat, clover and timothy, and maize. The remaining nine acres had borne a potato crop continuously for six or seven years, and on this particular section a system of deep ploughing had been practised. It has already been mentioned how radical cultivation of this type might obscure the effects of spraying.

At Robbinsville. On the whole the weather was very dry in this district of the State during the summer, but frequent showers helped to bring the rainfall up to about ten inches, extending over a period of about three months from 27th May, when spraying started, until the potatoes were dug. Shortly after the first treatment was made there were neither many flea-beetles nor Colorado beetles to be seen, although the infestation was quite severe on other fields planted with early " Cobbler " seed. The variety here treated was the " Green Mountain."

There were four series of plots, all approximately of the same size, except those of Series IV, which were less than half the area of the others. The general contour of the field was rather irregular, but this did not affect the results at all. Throughout the growing period, the foliage on the Bordeaux plots was easily superior to the foliage on the other plots, except in the first series, where, for some inexplicable reason, there was quite a lot of "tip-burn" in the Bordeaux plot, especially about 30th June. Early and late blights were conspicuous by their absence, while only a few hills were affected by dry rot (*Fusarium oxysporum*). Examination of the field on 16th August revealed the plants on the Bordeaux plots still green and quite vigorous, while on other plots they were quite dead. The potatoes were dug on 1st September and the following days, and an observer, casting his eye over the field, could with a little discrimination pick out the plots treated with Bordeaux mixture, by reason of their being less over-grown with weeds. This in itself would point to the invigorating effect of the mixture. The potato plants become so sturdy by reason of its application that they suffer less from competition with inimical weeds, especially crab-grass.

The very low yield on the Bordeaux plot of the first series might cause surprise. Indeed, no other plot in this block did so poorly, except one of the control plots where the yield was practically the same. Had it not been for the adverse conditions obtaining on this plot, the average yield in the Bordeaux plots as a whole would have been at least 20 bushels per acre more. Similarly, the adverse conditions which prevailed on the sulphur plot of Series IV helped to reduce the average yield

of tubers per acre on all the sulphur plots very materially. On the whole, however, experiments carried out on a large field such as this, are of more practical value than if only a few rows were treated. The variations in yield due to varying conditions of soil and fertility would sometimes seem to confute all accepted theories. Again, the results obtained may be such as to make the most sanguine theorist enthusiastic. But in order to demonstrate fully the capabilities of any spraying material, as well as those of the field on which the treated crop is grown, one must be fully acquainted with the several conditions which might influence the results either beneficially or adversely.

TABLE IV.

Yields of Tubers (Firsts and Seconds) at Robbinsville.

Nature of Application.	Yield in bushels per acre.								Average of the 4 series.	
	Series I.		Series II.		Series III.		Series IV.			
	1sts.	2nds.	1sts.	2nds.	1sts.	2nds.	1sts.	2nds.	1sts.	2nds.
Bordeaux and Lead Arsenate	223·06	8·86	297·85	12·90	317·99	10·32	265·62	25·00	276·13	14·27
Gypsum and Zinc Arsenite (control)	241·66	7·86	217·58	7·66	248·23	10·48	202·07	26·03		
	222·02	9·72	252·85	6·64	240·04	5·15	202·07	21·87	236·64	12·34
	259·25	13·88	240·62	9·37	296·20	18·14	217·11	11·33		
Sulphur and Zinc Arsenite	263·88	9·72	256·94	9·25	245·71	14·45	142·69	17·69	224·31	12·77
Electro-Bordo-Lead	247·68	9·25	234·79	6·80	297·34	14·96	228·12	25·00	251·98	14·00

Avg. gain in bushels per acre (firsts and seconds) of Bordeaux plots over control .. 41·41
Avg. gain in bushels per acre (firsts and seconds) of Bordeaux plots over sulphur .. 50·31
Avg. gain in bushels per acre (firsts and seconds) of Bordeaux plots over electro Bordo-lead .. .. 24·41
Avg. gain in bushels per acre (firsts and seconds) of Bordo-lead plots over control .. 17
Avg. gain in bushels per acre (firsts and seconds) of Bordo-lead plots over sulphur and zinc arsenite .. .. 25·9
Avg. decrease in bushels per acre (firsts and seconds) of sulphur and zinc arsenite plots below control .. .. 8·9

It will be observed by a glance at the last column that there is very little difference in the average number of bushels per acre of seconds, the divergence in yields being practically confined to the firsts.

As regards previous cultivation, the field at Robbinsville had borne a potato crop for three years (1912–13–14). In the autumn of 1912 it had been sown in rye, which was ploughed in the following spring. After the potato crop had been dug, this same operation was repeated in the autumn of 1913 and the spring of 1914. Fertiliser of the formula 4–8–10 was applied with the seed at the rate of 1,500 lb. per acre.

The following table will give an idea of this year's expenses at Freehold, Robbinsville and Elmer.

TABLE V.

Comparative Costs of Materials.

Chemicals experimented with.	No. of lbs. per application.	Time in hours.	Cost of labour of man and team per hour.	Cost of chemical per lb.	Cost per acre for each application.
Freehold.					
Bordeaux and Lead Arsen. (5.5.50)					
Bluestone ..	20			2½*d.*	
Lime	20	5	1*s.* 3*d.*	½*d.*	4*s.* 7⅜*d.*
Lead Arsen. ..	12			10*d.*	
Lead Arsen. ..	50	6	1*s.* 3*d.*	10*d.*	4*s.* 0⅛*d.*
Ansbacher's Bord.-Lead ..	41	3	1*s.* 3*d.*	5*d.*	5*s.* 4⅜*d.*
Sulph.Gyp.&Lead Arsen. (2–3–1) ..	144	3	1*s.* 3*d.*	3⅓*d.*	11*s.* 1¾*d.*
Robbinsville.					
Bordeaux and Lead Arsen. (5–5–50)					
Bluestone ..	30			2½*d.*	
Lime	30	7	11*d.*	½*d.*	7*s.* 1¼*d.*
Lead Arsen. ..	18			10d.	
Gypsum and Zinc Arsenite (5–1)	432	6	11*d.*	3⅛*d.*	9*s.* 8½*d.*
Electro-Bordo-Lead	72	3	11*d.*	5¼*d.*	8*s.* 3*d.*
Sulphur and Zinc Arsenite* ..	144	2½	11*d.*	2¾*d.*	8*s.* 4½*d.*
Elmer.					
Bordeaux and Lead Arsen. (5–5–50)					
Bluestone ..	13·5			2½*d.*	
Lime	13·5	1·5	1*s.* 3*d.*	½*d.*	6*s.* 5½*d.*
Lead Arsen. ..	7·5			10*d.*	
Lead Arsen. ..	30	1·5	1*s.* 3*d.*	10*d.*	5*s.* 3*d.*
Kil-Tone ..	27	1	1*s.* 3*d.*	6½*d.*	8*s.* 11*d.*
Sulphur and Lead Arsen. ..	61	1	1*s.* 3*d.*	3*d.*	9*s.*

The figures in the last column speak for themselves and at once show how the cost of similar treatments may vary in different places in the same State.

* At Robbinsville only three applications were made, except on the sulphur-zinc arsenite plots, where those of Series I and II received four treatments, as also 16 rows of the corresponding plot in Series III. In all other cases four applications were made.

Cost of Spraying and Dusting.

The expense of applying insecticides varies with the material and the type of machine employed in spraying or dusting, as the case might be. Even if we consider Bordeaux mixture alone, it would not be possible to state a cost which would hold good for all localities and for the various stages in the growth of the same crop within the same locality, because the degree of luxuriance of the foliage influences the amount of material necessary to cover the plants satisfactorily. Jones* states the average cost of spraying one acre of potatoes three times, using 200–500 gallons at one cent per gallon, as £1 9*s.* 4*d.* ($7).

Control of the Potato Flea-Beetle.

In New Jersey, as well as in most of the other potato-growing States, this diminutive insect has long been recognised as a serious pest, detrimental not only because of the damage committed directly by its fenestrating the leaves, but also indirectly, in that the injuries serve as a means of incursion for early blight. When one considers that in cases of severe attack, anything from 10 per cent. to 20 per cent. of the leaf surface on a single hill might be destroyed, one can form a somewhat rough idea of the adverse effect on the yield which this reduction in the assimilating power of the leaves causes.

Fig. 2. Potato Flea-Beetle (*Epitrix cucumeris*).
(After Chittenden.)

Probably on account of its insignificant size, very little attention has been paid to the life-history or means of control of the flea-beetle, and one author seems to accept without test what another may have previously experienced. Indeed, it is only quite recently that the true facts of its larval behaviour have been ascertained, and whereas it was generally accepted by Harris†, Riley‡, and Packard§ that the larva was a leaf-miner like others of its congeners, such as *Haltica nemorum*, the flea-beetle of turnips and other Cruciferae in England, it is only within recent years that it has been found to feed on the tubers and roots of the potato, as well as

* Jones, L. R.—Sixth Ann. Rept. Vermont Agr. Exper. Sta., 1892.

† Harris, T. W.—Insects Injurious to Vegetation, 1862, p. 127.

‡ Riley, E. V.—Missouri Rept. State Ent. I, 1869, p. 101.

§ Packard, A. S.—N. S. Geol. and Geog. Survey of Colorado and Adjacent Territory, 1875, p. 732.

on the roots of the tomato* and allied Solanaceous plants. The attack on the tuber gives rise to a condition known as "pimply," formerly assigned to the activities of the scab organism, the real cause having been discovered by Stewart.† The same author (*loc. cit.*) says that in 1895 in Long Island the damage was so noticeable that potatoes suffered a reduction in price of five cents (2½d.).

The omnivorous habit of the adult is well known, and although the species has a preference for the Solanaceae, yet it will feed on almost any of the commoner weeds found near the margins of potato fields. The following are some of the food-plants cited by various authors, the list being by no means exhaustive :—potato, tomato, eggplant and pepper (O. Lugger‡) ; Jamestown weed, nightshade (F. H. Chittenden§) ; radish, turnip, cabbage, raspberry, sunflower and various members of the squash family (C. M. Weed ||) ; beets (A. S. Packard¶).

An attempt was made during the season to arrive at some idea of the comparative intensity of the flea-beetle injury by making counts of the fenestrations on the leaves of individual shoots. Although a short table has been prepared showing the averages of these results, it is very doubtful if this method of gauging the degree of infestation is very successful, unless one can make daily records. This was impossible, because the spraying and dusting of the potatoes allowed only a short stay at a time at each place. However, the results, such as they are, have been tabulated in the hope that they may be of some use in stimulating others who have the opportunity to attack the problem along this line.

In one case, at Robbinsville, the Bordeaux mixture seemed to be less efficient than the gypsum and zinc arsenite in warding off the flea-beetle, and it almost appears as if dry poisons, for the time they remain on the leaves, are more effective in their repelling function than wet poisons. In the long run, however, by reason of their greater powers of adherence, the latter give the better results. At Freehold, on 9th July, the Bordeaux plots had the least injury, and similarly again at Robbinsville on 13th July, and at Elmer on 16th July. Unsprayed plants, as is to be expected, are more liable to flea-beetle injury, and at Elmer, 22nd August, on the late crop, the average number of holes per leaf was 32 during the second worst attack of the season. The intensity of the infestation at Elmer when the plants were yet young, can be judged by results obtained on 10th June. Here the Bordeaux and lead arsenate combination proved its qualities in keeping the pest at bay.

The fact that the average number of injuries, as judged from Table VI., were much greater at Elmer on 10th June, is due to the fact that the counts were made on the large radical leaves, which, on account of their having appeared first, suffered greater cumulative damage than the younger leaves on the top shoots, which alone were considered in the later reckonings.

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* Chittenden, F. H.—Bull. No. 19 N. S., U.S. Dept. Agr., 1899, p. 89.

† Stewart, F. C.—Bull. 113, N.S., N.Y. Agr. Exper. Sta., Geneva, 1896, p. 311.

‡ Lugger, O.—Bull. 66, Minn. Agr. Exper. Sta., 1890, p. 247.

§ Chittenden, F. H.—*Loc. cit.*, p. 90.

|| Weed, C. M.—Bull. 29, N.H. Coll. Agr. Exper. Sta., 1893, p. 3.

¶ Packard, A. S.—*Loc. cit.*, p. 732.

TABLE VI.

Intensity of Flea-Beetle Injury.

Nature of Application.	Date.	Locality.	No. of shoots.	Average no. of leaves per shoot.	Average no. of fenestrations per leaf.
Untreated	June 10	Elmer	20	15	154·5
Bordeaux-Lead Arsenate	,,	,,	20	15	92
Kil-Tone	,,	,,	20	15	142
Lead Arsenate	,,	,,	20	15	138·6
Sulphur-Lead Arsenate..	,,	,,	20	15	208·4
Bordeaux-Lead Arsenate	June 29	Robbins-ville	20	14	9·3
Vreeland's Electro Bordo-Lead ..	,,	,,	20	15	9·7
Gypsum-Zinc Arsenite ..	,,	,,	23	14	8·3
Sulphur-Zinc Arsenite ..	,,	,,	15	13	11
Untreated	July 1	Freehold	23	13	7·7
Untreated	July 9	,,	24	13	9
Bordeaux-Lead Arsenate	,,	,,	26	9	4·9
Ansbacher's Bordeaux-Lead	July 10	,,	29	9	7·15
Lead Arsenate	,,	,,	29	9	6·3
Sulphur-Gypsum-Lead Arsenate	,,	,,	23	9	7·7
Bordeaux-Lead Arsenate	July 13	Robbins-ville	33	11	8·9
Vreeland's Electro Bordo-Lead ..	,,	,,	30	8	21·5
Gypsum-Zinc Arsenite ..	,,	,,	22	8	13·54
Sulphur-Zinc Arsenite ..	,,	,,	21	9	13
Bordeaux-Lead Arsenate	July 16	Elmer	27	13	15
Kil-Tone	,,	,,	28	14	28
Lead Arsenate	,,	,,	25	15	21
Sulphur-Lead Arsenate..	,,	,,	29	14	28
Untreated (late crop) ..	Aug. 22	,,	23	9	32

The total destruction of the flea-beetle, like that of any other insect pest, would mean unlimited expenditure and is practically impossible. As an insect indigenous to the United States, this pest will for ever, as long as potatoes are grown, levy a tax upon the farmer ; so that the question resolves itself into one of reducing the tax to a minimum by some measure of control. Three principal methods of attack have been employed in abating injurious insect pests, classified as follows :—

(1) Treatments which kill the insects ;

(2) measures that will restrict their abundance and act temporarily as repellants ;

(3) natural checks, such as insect or fungous parasites.

Hitherto it has been the general plan to tackle the problem of flea-beetle control by means of repellants, and although arsenate of lead and Bordeaux mixture have on many occasions proved efficient, several of the inert powders and dusts recommended are practically of little benefit. Because of its activities and peculiar habits, the problem of killing the insect outright presents many difficulties. It is essential for the rapid administration of a lethal dose, that the material employed must actually hit the insect and be retained there until the animal is paralysed beyond recovery. What I have in mind is pyrethrum mixed with an adhering agent such as gelatin, glue, or soap. After some experiments had been carried out in the laboratory with several different substances hereafter tabulated, it was decided to try some of these on early and late potatoes with a view to discovering an agent capable of killing the beetles quickly. An infusion of pyrethrum mixed with lead arsenate in which gelatin is incorporated, gave most satisfactory results. This combination insecticide is made up in the proportion of 6 lb. of pyrethrum to 60 gals. of water, to which sufficient gelatin or soap is added to ensure that a film of the liquid will adhere readily, when sprayed on the leaves. In preparation, the pyrethrum is first made into a paste by the addition of hot boiling water, then diluted with hot water and cooled, and then further diluted to the required strength with cold water, the gelatin solution being previously stirred in. To get the best results, this insecticide should be applied at 100 lb. pressure so that it hits the plants as a fine mist.

There is one circumstance which appears to be worthy of attention. In spraying or dusting against the flea-beetle, it is the custom to have the operating machine drawn by the horses between the rows of the potato plants. On account of the great activity of the pest and its readiness to escape at the slightest disturbance, it was observed that the movement of the team caused the beetles to clear away from the foliage before the spray fluid could reach them. Therefore, if it could be contrived, it would be a decided advantage to have the machine pushed between the rows, instead of drawn.

The laboratory experiments were carried through in lamp-globes covered with muslin. Inside the globes a small vessel for holding water was placed, into which slips cut from the potatoes and treated with the various preparations tabulated, were put. Flea-beetles in varying numbers, which were always previously counted, were then introduced and the effects noted after a period of hours or days, as the case might be. The penultimate column of the table which follows records the percentage mortality,

TABLE VII.

Experiments in Control of the Potato Flea-Beetle.

Material.	Strength of material.	No. of specimens.	Duration of test.	Alive.	Dead.	Percentage mortality.	Remarks.
Zinc Arsenite, powder ..	———	20	2 days	2	18	90	All dead after three days.
Zinc Arsenite, paste ..	4 lb. to 50 gals.	48	2 days	4	44	91·6	Plants killed.
Zinc Arsenite, paste ..	4 lb. to 50 gals.	50	2 days	40	10	20	All dead after nine days.
Paris Green, powder ..	———	40	3 days	5	35	87·5	All dead after seven days.
Paris Green, powder ..	———	65	3 days	15	50	76·9	All dead in ten days.
Tobacco Dust	———	36	1 day	3	33	91·6	The effect seems to vary, acting quickly on some and less so on others.
Hellebore, powder ..	———	60	2 days	6	54	90	Acts quickly, but loses effect rapidly.
Bordeaux, Lead Arsenate and Black-Leaf-40	5–5–50, 3 lb., 1 pint	51	2 days	24	27	52·9	All dead in six days.
Zinc Arsenite and Black-Leaf-40	3 lb., ½ pint, to 50 gals.	86	6 days	20	46	69·6	Leaves become chlorotic and die.
Lead Arsenate and Black-Leaf-40	3 lb., ½ pint, to 50 gals.	66	6 days	14	52	78·7	Leaves burnt by arsenic.
Lead Chromate, powder	———	45	10 days	36	9	20	No injury to leaves, but not efficient as insecticide.
Lead Chromate and Black-Leaf-40 ..	3 lb., ½ pint, to 50 gals.	68	4 days	50	18	25·4	No injury to leaves.
Lead Arsenate and Molasses ..	3 lb., 3 lb., to 50 gals.	52	7 days	16	36	69·2	No injury to leaves at first, but finally turned yellow and died.
Lead Arsenate and Molasses ..	3 lb., 3 lb., to 50 gals.	66	5 days	39	27	40·9	No injury at first ; chlorosis followed.
Lead Arsenate and Molasses ..	3 lb., 3 lb., to 50 gals.	48	5 days	19	29	64·1	No injury at first ; chlorosis followed.
Black-Leaf-40 and Soap	1 pint, 4 lb., to 100 gals.	75	2 days	30	45	60	Leaves considerably eaten.
Black-Leaf-40 and Soap	2 pints, 4 lb., to 100 gals.	60	2 days	26	34	56·6	Leaves considerably eaten.
Barium Chloride and Molasses	2 % sol. with 5 lb. molas. to 100 gals.	72	3 days	26	46	63·8	Kills plants quickly ; valueless.
Pyrethrum, powder ..	———	60	6 hrs.	0	60	100	Very effective, but rapidly becomes weak in its action.
Pyrethrum and Sulphur	Equal parts	50	6 hrs.	5	45	90	Those still alive feeble in their movements ; did not recover.
Pyrethrum Infusion ..	6 lb. to 60 gals.	50	10 hrs.	2	48	96	If covered for only 2 hours the insects revive.
Sulphur, powder ..	———	46	1 day	46	0	0	No feeding done.
Bor-Deth, powder ..	———	54	2 days	24	30	55·5	Non-injurious to the plants.
Pyrox	8 lb. to 50 gals.	46	4 days	14	22	47·8	Non injurious to the plants.

but this is only of interest in so far as it gives one an indication merely of the value of the insecticides. The conditions were too unnatural to allow of the experiments being a real test.

A Hymenopterous Parasite of the Flea-Beetle.

Throughout the summer, from the middle of July until the beginning of September, when a period of rather low temperature was experienced, driving the flea-beetle into hibernating quarters, a small species of Braconid was often observed in close association with it on the potatoes. Specimens sent to Dr. L. O. Howard, Chief of the Bureau of Entomology, Washington, D.C., were transmitted to Mr. J. C. Crawford of the National Museum, who kindly identified them as *Perilitus epitricis*, Viereck. As it so happened, the occurrence of this species in New Jersey proved interesting, as being a new record for this State.

The following observations were made on 30th July. As the flea-beetle moves over the leaf surface, the Hymenopteron follows closely in the rear with its two antennae outstretched, one on each side of its prey. Whenever the latter stops, the Braconid follows suit and remains often perfectly motionless. Sometimes, however, it becomes quite excited and rapidly encircles its host in a curious, terpsichorean fashion. When about to attack, the Hymenopteron orients itself, either anteriorly or posteriorly, in a direct line with the flea-beetle and artfully recurving its abdomen downwards and forwards, strikes it in the vulnerable places of its armour, the intersegmental parts of the abdomen. Thus the act of oviposition is completed, but apparently not always successfully, for the aggressive action may be repeated several times in the same host by the same parasite. From various specimens of flea-beetles collected during the summer and maintained in captivity, this parasite was reared. The point of emergence is a hole usually found in the anal region of the parasitised beetle.

In conclusion I wish to express my warmest thanks to Dr. T. J. Headlee, State Entomologist, who during my sojourn in the United States gave me the greatest assistance in carrying out this work, while he has always been ready with valuable hints and suggestions as to the methods to be employed. My thanks, too, are due to the Experiment Station authorities who made it possible to carry through the experiments to completion. My only regret is that unforeseen and unavoidable circumstances necessitated the rather hurried writing up of the results.

Summary.

In employing the most up-to-date methods in the prosecution of his business, the American farmer endeavours to get the best return for his labours. The adoption of the latest prophylactic measures for combating the fungus and insect enemies of his crops, is but a single instance of that progressiveness which is characteristic of the man.

The State Agricultural Experiment Stations encourage the farmer in many ways and are of genuine practical value in dealing with local problems. The establishment of similar institutions in this country would be quite justifiable.

The experiments with various fungicides and insecticides were carried out in the State of New Jersey. They were intended to demonstrate how a larger yield of potato tubers per acre might be procured by the employment of scientific methods of spraying and dusting.

The principal fungus diseases attacking the potato are early blight (*Macrosporium solani*), late blight (*Phytophthora infestans*), and dry rot (*Fusarium oxysporum*). Late blight, which levies a heavy toll on the potato crop in America, is injurious in New Jersey only in exceptionally wet seasons. A pathological condition of the leaves known as " tip-burn " is in some years responsible for a reduced yield.

Of the various treatments applied, Bordeaux mixture vindicated itself in each case. It is not only a most excellent fungicide, but also an effective insecticide when arsenate of lead is added. Both the Colorado and flea-beetles were better controlled by the Bordeaux-lead arsenate mixture than by any of the other insecticides used in the field experiments.

Bordeaux mixture acts as a plant stimulant by maintaining the green colour of the leaves for a longer period. This naturally means larger tubers.

Thoroughness of application of the Bordeaux mixture and frequent repetition of the treatment, at least once every ten days, are necessary for effectiveness. Care in its preparation is strongly advised. Sufficient lime must be used to ensure that all the copper sulphate is changed to the hydrate form, otherwise burning of the leaves may ensue.

The use of Bordeaux mixture may increase the value of the yield of tubers anything from £3–£5 per acre. The increase, however, varies considerably in different localities and in different years.

Sulphur did not quite realise expectations as a crop stimulant. Various proprietary Bordeaux mixtures proved less economical and less efficient than the home-made article.

The cost of spraying or dusting varies according to the locality, but of all the treatments applied, home-made Bordeaux mixture always proved cheapest.

Concurrent experiments carried out in the laboratory and field with many insecticides additional to those used in the large field tests, were the means of discovery of an insecticide which seemed to fulfil all requirements in controlling the flea-beetle. It is composed of a combination of pyrethrum infusion, gelatin or soap, and lead arsenate. Extended trial will, however, have to be made to establish its efficacy.

The fenestration of the leaves by the flea-beetle, besides materially reducing the assimilating surface of the leaves, also renders the injured tissue more susceptible to the attack of various cryptogamic diseases. This is notoriously true of early blight.

Counts made of the fenestrations of the leaves on a large number of shoots, gave an idea of the intensity of the damage caused by the flea-beetle at any one period. A comparison of the counts made on plants treated with different substances, supplied a rough estimate of their value in controlling the pest.

For a true interpretation of the results of the field experiments various factors must be considered, amongst which not least are the physical and chemical conditions of the soil, previous cultivation and the vagaries of the weather.

A Braconid parasite (*Perilitus epitricis*) of the flea-beetle was reared from adult captured specimens. Its behaviour in relation to its host was closely observed in the field, especially the manner of its oviposition. No figures were obtained of the percentage of parasitism, but it is considered that the Hymenopteron is practically a negligible factor of control.

"Iron Age" machine spraying potatoes with Bordeaux mixture.

A dusting machine.

Fig. 1. A potato field at Elmer, New Jersey; the plot to the right of the photograph has been treated with Bordeaux mixture, and the plants are healthy and vigorous.

Fig. 2. The same field, on the same day, showing a control plot treated with lead arsenate, adjacent to that represented in the photograph above. Note the marked difference in the foliage.

ON THE BRITISH SPECIES OF SIMULIUM.—I. THE ADULTS.

By F. W. Edwards.

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The theories at present widely accepted regarding the connection between the Simuliidae and pellagra have brought this family of blood-sucking flies very much to the front in recent years, and have rendered it highly desirable that accurate information should be available concerning the different species, their distribution and habits. It is in the hope that the facts brought forward may be of use at some future time, and that the way may be cleared for further research, that the present investigation has been undertaken. The writer has examined over 1,000 pinned specimens, including the material in the British Museum, the Cambridge Museum and the Edinburgh Museum, together with a large number of additional specimens kindly lent by various private correspondents. The result of this examination will, it is believed, go some way towards an elucidation of the European species of this family.

No exact work has ever been published upon the British species, and although a large number of names have been applied to European forms, the descriptions are for the most part unrecognisable. Recently, however, Dr. C. Lundström has given us an account of the Finnish species.* In this paper for the first time some attention is paid to the male genitalia, and a number of figures of these organs are given. Lundström, however, has not studied them sufficiently closely, and does not mention other equally important characters, such as the female claws. Another very valuable paper is that published last year by J. R. Malloch on the American species.† This, however, has one serious fault, in that it ignores genital characters. The present writer is largely indebted to both these papers for suggestions as to the classification and description of the British species. For reasons which will be given later, however, it has not been thought advisable to follow Malloch and Roubaud in subdividing the genus *Simulium*.

The writer is indebted to the following gentlemen for the loan of specimens (the initials in brackets after the collectors' names are those used in the subsequent part of this paper): Messrs. E. A. Atmore (A.); A. E. J. Carter (Ct.); J. W. Carr (Cr.); J. E. Collin (C.); P. H. Grimshaw (G.); A. H. Hamm (H.); F. Jenkinson (J.); J. J. F. X. King (K.); C. G. Lamb (L.); C. Morley (M.); Lt.-Col. C. G. Nurse (N.). In addition the following collectors, among others, have presented specimens to the British Museum: Messrs. F. W. Edwards (E.); A. Piffard (P.); G. H. Verrall (V.); Lt.-Col. J. W. Yerbury (Y.).

General Morphology.

It is not the purpose of this paper to give a full account of the adult structure in *Simulium*, but attention may be called to a few points which have either been in dispute or have not been previously noted.

* 'Beiträge zur Kenntnis der Dipteren Finlands. vii Melusinidae (Simuliidae).' Acta societatis pro Fauna et Flora Fennica, xxxiv, no. 12, 1911.

† U.S. Dept. of Agric., Bureau of Ent., Technical Ser. no. 26. 'American Black Flies or Buffalo Gnats.'

Antennae.—These have been variously stated to be 10- or 11-jointed, Brunetti even as late as 1913 claiming that only 10 joints are present. All the species which I have examined, however, agree with Meigen's description in having 11-jointed antennae.

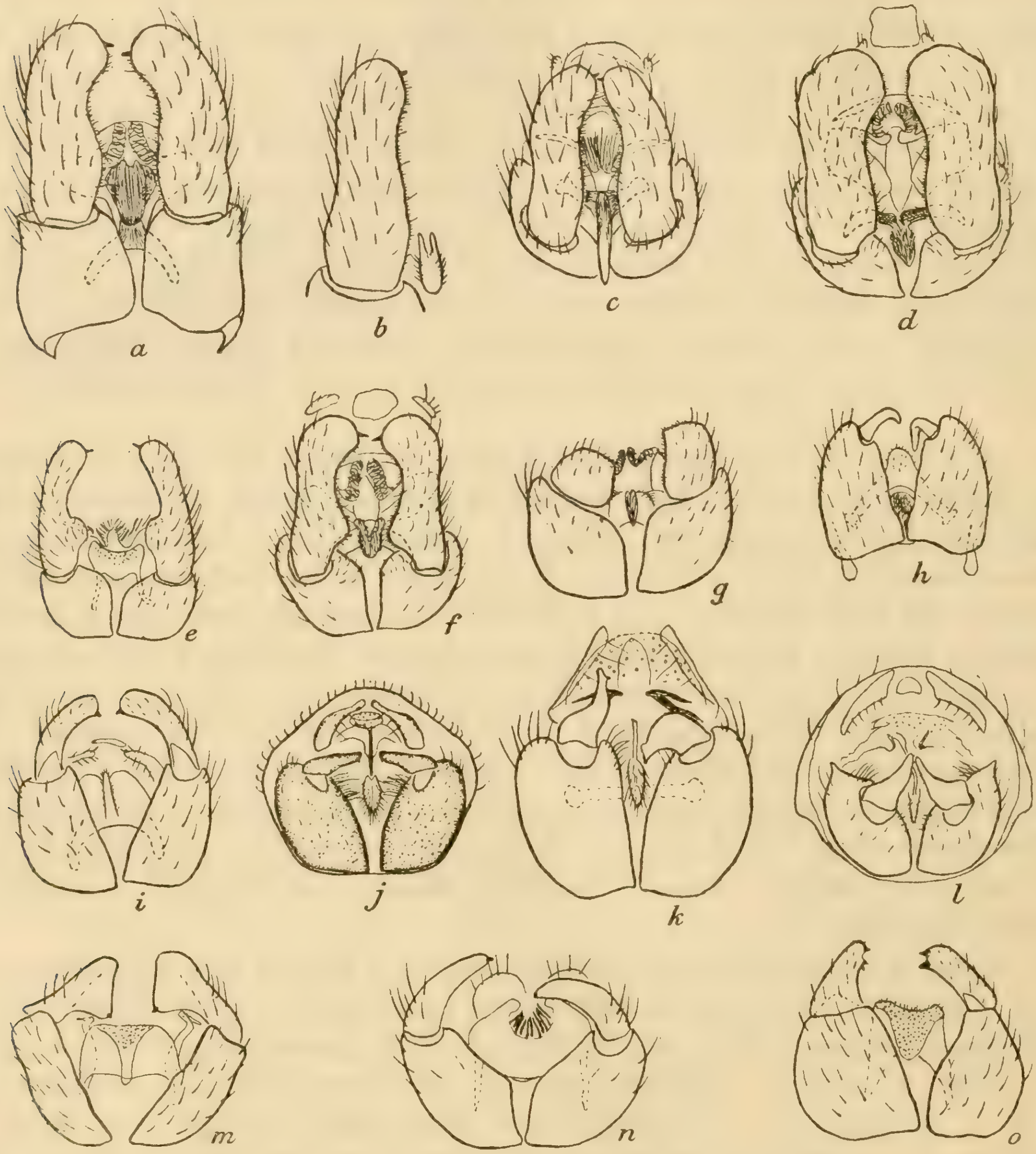

Fig. 1. Male genitalia of British *Simulium*, as seen from beneath, all × 75, (except in figs. *j* and *l* the ninth tergite has been removed) :—*a, S. ornatum* ; *b, S. variegatum*, clasper and external part of adminiculum ; *c, S. reptans* ; *d, S. morsitans* ; *e, S. tuberosum* ; *f, S. austeni* ; *g, S. argyreatum* ; *h, S. equinum* ; *i, S. aureum* ; *j, S. angustipes*, a specimen from Wells, Som. ; *k*, the same, from Sligo ; *l*, the same, in a different position, from Nairn ; *m, S. latipes* ; *n, S. subexcisum* ; *o, S. hirtipes.*
In figs. *c, d, f, i, j, k, l* and *n* the *appendices superae* are shown, but in the rest they have been removed with the ninth tergite.

Mouth-parts.—These have never been very accurately described, the best description still being that of Meinert in his well-known paper on the mouth-parts of Diptera. It has sometimes been stated that in *Simulium* the mouth-parts of the male are

much less developed than those of the female, the mandibles being absent in the former sex. This is not the case; the male *Simulium* of several species examined microscopically by the writer had both mandibles and maxillae fully developed, and these organs only differed from those of the female in being somewhat more pointed and in having only fine hairs instead of sharp teeth along their margins; besides this, the labium has more numerous sensory papillae in the male than in the female. Lt.-Col. Alcock, in his recent book, *Entomology for Medical Officers*, states that the mandibles of the female are toothed on the inner edge, the maxillae on the outer. This is indeed the appearance under a low magnification, but if a sufficiently high power be used, it can be seen that both mandibles and maxillae are toothed along both edges. No specific differences were observable in the mouth-parts.

Alcock has called attention to the well-marked sensory vesicle in the second joint of the palpi. So far as I am aware this is the only reference to this organ in the literature of the Diptera, but I believe its study in this and related families of flies might yield valuable results from the point of view of phylogeny. I have noticed a very similar structure in Mycetophilidae, and (in a reduced form) in certain Blepharoceridae.

Abdominal scale.—The peculiar structure characteristic of this family, situated at the base of the abdomen and clothed with long hair, has sometimes been regarded as belonging to the abdomen and sometimes to the thorax. After having made careful dissections of cleared specimens, I am convinced that it represents the first abdominal tergite. It is more or less completely divided into a large dorsal and two smaller lateral pieces, and seems to be in some way connected with a very large internal development of the hind coxae.

Male genitalia.—These have been described by Lundström, but it is perhaps advisable to give a short redescription to explain the terms used. As in other Diptera, the genitalia are extremely important for specific distinctions. The ninth tergite (*lamella terminalis*) is well developed and entirely covers the other organs, which in the dry specimen can therefore only be seen from the ventral side. It has attached to its posterior margin three small chitinous pieces, of which the two lateral ones (*appendices superae* or *oberen Anhänge*) are more or less hairy. These appendages undoubtedly exhibit useful specific characters, but I have not paid much attention to them, as, in order to facilitate the examination and drawing of the more important ventral parts, I have usually dissected away the ninth tergite with the *appendices superae* attached. The most important parts are the large side-pieces (*appendices intermediae* or *Zange*) together with the claspers which are articulated to them. Owing to the absence of the ninth sternite, these organs have taken up a more ventral position than usual in the Nematocera; their structure can usually be made out without dissection even in a dry specimen. Between the ninth tergite and the side-pieces, and more or less completely hidden by them, is the adminiculum, with its appendages (*Arme* and *Griffel*). This organ, though subject apparently to some amount of individual variation, provides one of the means of separating certain closely allied species.

Tarsi.—Important specific characters are to be found in the thickness and relative lengths of the joints of the front tarsi in both sexes, and of the hind tarsi of the

male, though I believe that here again there is a certain amount of individual variation. The female claws also yield important characters, though, like Malloch, I have been unable to discover any differences in the male claws.

So far as I am aware, no previous writer has noted the well-marked pulvilliform margin of the fourth tarsal joint (see fig. 4, *a*, etc.) which seems to have been developed instead of true pulvilli, of which I have not been able to find any trace. This condition of the fourth tarsal joint is found in both sexes and all species.

The second hind tarsal joint of nearly all species, as pointed out by Roubaud and figured by Malloch and others, has a distinct dorsal excision near the base (fig. 6, *a*). For the species in which this excision is not found (represented in Britain by *S. hirtipes*, fig. 6*b*) Roubaud proposed the subgenus *Prosimulium*, and Malloch has adopted this name in a generic sense. The latter writer has also called attention to the possession of an additional vein in the wings by most species of *Prosimulium* (*e.g.*, *S. hirtipes*, fig. 5, *b*). But as intermediates are found with regard to both these characters (*e.g.*, *S. meridionale* and *S. subexcisum* in respect of the tarsi, and *S. mutatum* and *S. pecuarum* in respect of the wings), and as other characters (*e.g.* the female claws) do not support the division, I have considered it inadvisable at present to make any use of the term *Prosimulium*, and prefer to regard all the species as constituting a single genus. A more natural division of the genus, at least so far as the British species are concerned, seems to be the one adopted in this paper.

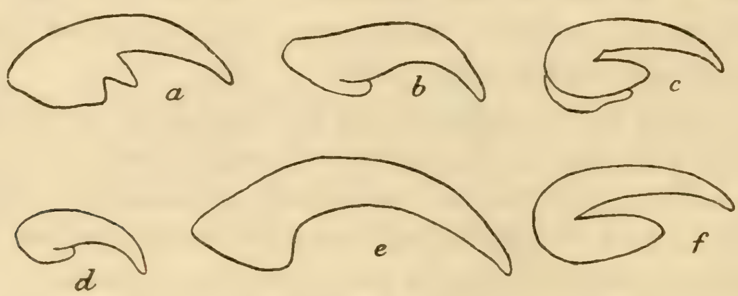

Fig. 2. Female claws of *Simulium*, × 325: *a*, *S. ornatum*; *b*, *S. argyreatum*; *c*, *S. latipes*; *d*, *S. tuberosum*; *e*, *S. equinum*; *f*, *S. subexcisum*.

Blood-sucking Habits.

It would appear to be the case that not all the species are addicted to blood-sucking habits, notwithstanding the fact, already alluded to, that the mouth-parts are equally developed in the females of all the species. Our two commonest species, *S. ornatum* and *S. latipes*, have never, so far as I am aware, been recorded as biting either man or other animals; while Dr. A. Lutz, whose admirable work on Brazilian biting flies is well known, made some observations on the habits of *S. ornatum* in the neighbourhood of Bath last summer, and formed the opinion that it never does bite. On the other hand, *S. reptans* and its near allies, and *S. equinum*, are serious pests in certain districts, but these species, fortunately, are more restricted in their range. More exact knowledge on this subject is a desideratum.

Classification.

The British species of *Simulium* fall readily into two groups, which may be defined as follows :—

Group A.—Tibiae of the front and middle legs with a large patch of silvery-grey dusting on the front or outer side ; legs and abdomen with very fine hair-like pubescence ; thorax and abdomen of the male usually with silvery markings ; last three abdominal segments of the female shining ; front tarsi more or less thickened ; halteres always light yellow ; male genital claspers flattened dorso-ventrally.

Group B.—Tibiae without any silvery-grey dusting ; if the front tibiae sometimes appear silvery, this is owing to the colour of the pubescence ; legs and abdomen more or less densely clothed with a coarse close-lying pubescence, which is almost scale-like and usually yellowish or golden ; thorax and abdomen of the male without silvery markings ; abdominal integument of the female entirely dull ; front tarsi not at all thickened ; halteres often dark ; male genital claspers diverse in form, but never flattened dorso-ventrally and usually roundish in section.

Group A.

Table of males.

1. Hind tibiae and metatarsi conspicuously pale on the basal half	2
Hind tibiae pale only at the extreme base, if at all	3
2. Front metatarsi about $6\frac{1}{2}$ times as long as broad	*ornatum*
Front metatarsi about 5 times as long as broad	*variegatum*
3. Hind metatarsi mainly dark and more or less thickened	4
Hind metatarsi largely pale and not at all thickened	*argyreatum*
4. Middle tibiae conspicuously yellowish or silvery on the basal third or half	*reptans*
Middle tibiae entirely or almost entirely black (for distinctions between these three species see figures of genitalia) ..	*tuberosum, morsitans, austeni*

Table of females.

1. Frons greyish, dull	2
Frons blackish, shining	3
2. Fore and mid femora darkened on the apical half	*ornatum*
Fore and mid femora entirely or almost entirely yellow	*variegatum*
3. Face dull greyish	4
Face shining blackish like the frons	*tuberosum*
4. Thorax somewhat shining, with scarcely a trace of silvery-grey lateral patches towards the front	*argyreatum*
Thorax scarcely shining, with coarser pubescence and fairly distinct silvery-grey lateral patches towards the front	5
5. Pale markings of legs sharply defined ; hind metatarsi clear yellow on the basal half	*reptans*
Pale markings of legs less sharply defined ; basal half of hind metatarsus more smoky yellow	6
6. Abdomen distinctly yellow at the base*	*morsitans*
Abdomen not yellow at the base*	*austeni*

* This is only a doubtful distinction, as I have seen only one female which can with any reasonable certainty be associated with the males described as *S. austeni*.

1. **Simulium ornatum,** Mg. (figs. 1, 2, 3 and 4).

Length, 2·5–4·5 mm.

Male.—Antennae all black, as in every other British species. *Thorax* velvet-black (as in all the species of this group), clothed uniformly and fairly densely with a short, close-lying golden pubescence ; in front with a pair of shimmering silvery spots, narrowly or broadly separated in the middle ; about half only of these spots reflects light at one time ; in certain lights the side and hind margins of the mesonotum are also silvery. Pleurae with a patch of soft hairs between the prothoracic spiracle and the base of the wing, on the area called by Malloch the " membranous patch." These hairs, though very easily rubbed off, provide an important specific character, as there are only two other British species which possess them. *Abdomen* velvet-black, with the silvery lateral spots on segments 2, 6 and 7 as usual in this group. The long hair on the " basal scale " varies in colour from yellow to black ; long hair is also present along the sides. *Genitalia* (fig. 1, *a*) : basal lobe of side-pieces short, the claspers long, strap-shaped, slightly curved, of even width throughout, with a single short spine near the tip on the inner edge. Adminiculum broad, thumb-like. Little or no variation appears to occur in the genitalia of this species ; about 15 specimens were carefully mounted and compared. *Legs :* front pair black, the tibiae silvery on the outside ; femora clothed rather densely with long black hair, and a few rather long hairs at the tips of the tarsal joints, which are moderately flattened and expanded. Middle and hind legs dark brown to blackish, the basal quarter of the femora, basal third or half of the tibiae, base of the mid metatarsi and basal half or three-fifths of the hind metatarsi, brownish yellow. Hind metatarsus (fig. 4, *a*) nearly as broad as the tibia.

Female.—Head entirely dull silvery-grey ; antennae black, the two basal joints usually, but not always reddish. *Thorax* dull greenish black, with fine golden pubescence as in the male ; in front with large silvery grey lateral patches, which are only narrowly interrupted by ground-colour in the middle, and include a dull black transverse stripe, which when viewed from behind becomes silvery, while the silvery parts become blackish. Pleurae with the same patch of soft hair as in the male. *Abdomen* with the long hair on the basal segment yellowish ; second segment black above, silvery grey at the sides ; segments 3–5 dull black in the middle, with whitish patches posteriorly on the membranous sides, bare ; segments 6–8 shining, with rather sparse fine yellowish hair. *Legs* much as in the male, but the enlargement of the front tarsi (fig. 3, *a*) is rather more noticeable, the hind metatarsi are much less thickened, the front femora are scarcely hairy, and the pale markings, especially of the middle and hind tibiae, are more extensive ; the ground colour of the front tibiae dark ; occasionally the front and middle femora are largely pale, though they are always darkened at least at the tips. All the coxae dark. Claws (fig. 2, *a*) with a distinct tooth near the base.

Time of appearance.—The dates of capture of the specimens I have examined range more or less continuously from 13th March to 20th August, though the great majority were taken during April and May. Stray specimens have also been taken in October, and even (in the Channel Islands) at Christmas.

Distribution.—*S. ornatum* is probably common everywhere, wherever running water is available, though apparently it is less common towards the north. I have

the following records :—ENGLAND : Padstow, Cornwall (*L.*) ; Taunton (*Miss B. K. Taylor*) ; Wells, Somerset (*L.*) ; New Forest (*H.*, *S.*, *V.*, *Y.*) ; Crowborough, Sussex (*J.*) ; Lee, Kent (*V.*) ; Weybridge, Surrey (*V.*) ; Wilton (*J.*) ; Netheravon (*Capt. E. P. Argyle*) ; Burnham Beeches (*E.*) ; Felden and Bricket Wood, Herts. (*P.*) ; Bath (*Dr. A. Lutz*) ; Crickleigh, Glos. (*R. Newstead*) ; Cambridge (*J.*) ; Whittlesford, Cambs. (*L.*) ; Newmarket (*V.*) ; Ampton, West Stow and Tuddenham, Suffolk (*N.*) ; Colwick Park, Staffs. (*V.*) ; Oxford (*H.*) ; Sherwood Forest and West Leake, Notts. (*Cr.*, *Y.*) ; Burley in Wharfedale (*G.*). WALES : Porthcawl and Llangammarch Wells (*Y.*). SCOTLAND : Kilmarnock (*K.*) ; Braidwood, Lanarks. (*K.*) ; Bonhill, Dumbarton (*K.*) ; Hawkhead, Renfrew (*K.*) ; Edinburgh (*Ct.*, *G.*) ; Nethy Bridge, Inverness (*K.*) ; Logie, Elgin (*J.*) ; Loch Assynt, Sutherland (*Y.*). IRELAND : Clare Island (*G.*).

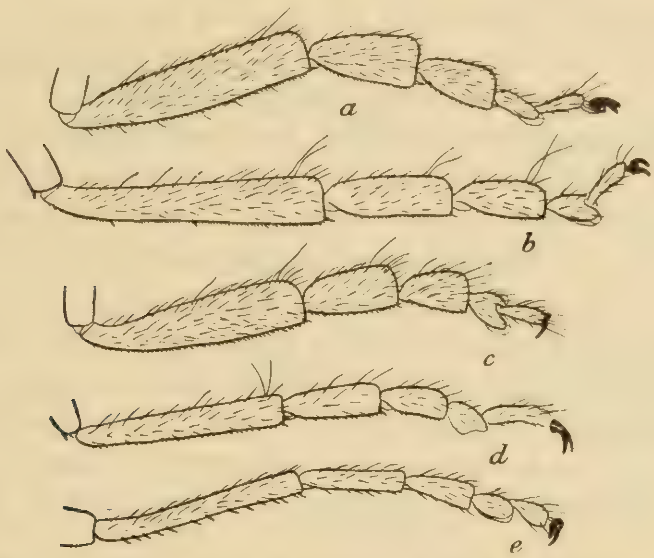

Fig. 3. Front tarsi of female, British *Simulium*. All × 40. *a*, *S. ornatum* ; *b*, *S. variegatum* ; *c*, *S. reptans* ; *d*, *S. equinum* ; *e*, *S. subexcisum*.

Habits.—As previously mentioned, it is doubtful whether this species is a blood-sucker, the only record suggesting that it may be so being a note on a specimen collected by Capt. E. P. Argyle to the effect that it was found on a pony's side. Prof. J. W. Carr found numbers of females flying in a swarm, some of the members of which were biting, but as the swarm also contained *S. argyreatum* and *S. equinum*, it is probable that these species were the offenders. Mr. F. Jenkinson has also observed (at Wilton) a large swarm composed of females of this species and *S. equinum*. Prof. R. Newstead has made some interesting observations on the habits of this species. He says (Ann. Trop. Med., i, p. 40) : " Occasionally the insects were seen completely immersed in the water, where they seemed at perfect ease either when walking along the stems of the plants or cleaning their legs and antennae. In such cases the wings were folded partly round the abdomen, so that they tapered to a point behind, and in this way were seen to form a large air cavity. This remarkable trait was observed in still water only."

Synonymy.—There can be no doubt that this is the species described by Meigen, though *Culex sericeus* of Linnaeus may be an older name for it ; at any rate Meigen's description of *S. sericea* almost certainly indicates *S. ornatum*, rather than *S. reptans*,

under which it is sunk in the Catalogue of Palaearctic Diptera. I also consider that *S. auricoma* and *S. fasciata* of Meigen, and *S. crassitarsis* of Macquart are really only *S. ornatum*, though *S. auricoma* appears as a synonym of *S. latipes* in the Palaearctic Catalogue. Curtis' *S. trifasciatum* is undoubtedly a synonym, and Macquart's *S. tibiale* and *S. vernum* may perhaps be others. Lundström, believing the genitalia to be variable, described the species as a variety of *S. reptans*, but the two are perfectly distinct, even Meigen having appreciated some of the differences between them.

2. **Simulium variegatum,** Mg. (figs. 1, 3).

Closely allied to *S. ornatum*, but differs in the following particulars :—Front tarsi (fig. 3, *b*) in both sexes markedly longer and thinner ; no sign of soft hairs on the pleurae between the prothoracic stigma and the base of the wing ; male genitalia (ten specimens compared) with the adminiculum (fig. 1, *b*) rather smaller ; legs of female much paler, the front coxae and femora being entirely yellow, and usually the middle femora also, though sometimes these are somewhat darkened towards their tips ; the ground colour of the front tibiae is yellow, except on the apical fourth. These differences, though for the most part slight, are I believe constant.

Time of appearance.—From 18th April to 20th September.

Distribution.—Scotland : Gorge of Avon, nr. Hamilton, Lanarks. (*K.*) ; Cleghorn, Lanarks. (*K.*) ; Bonhill, Dumbarton (*K.*) ; Forres (*K.*) ; Kirkcudbright (*K.*) ; Comrie and Blairgowrie, Perth (*Ct.*) ; Nethy Bridge, Spey Bridge, Aviemore, Kincraig, Dunachton and Corrour, Inverness (*K.*, *Y.*, and *G.*) ; Logie, Elgin (*J.*) ; Dingwall, Cromarty (*K.*, *Y.*) ; Loch Assynt, Sutherland (*Y.*). Ireland : Cappoquin, Co. Waterford (*K.*) ; Wexford (*K.*) ; Newcastle, Co. Down (*K.*). England : Aysgarth Force (*G.*).

From the above list of localities it would seem that this species is confined to comparatively high altitudes, where it to a large extent replaces *S. ornatum*.

Synonymy.—As Meigen lays stress on the yellow femora I think the species must be correctly identified, though it has not been properly distinguished before. The Palaearctic Catalogue places *S. variegatum* as a synonym of *S. reptans*, but I cannot accept this, as I have not seen a single specimen of *S. reptans* with yellow femora. *S. varium*, Mg., would seem from the description to be *S. variegatum*. Zetterstedt describes it as *S. ornatum* var. *b*, but I think the structural difference in the front tarsi is sufficient to entitle it to specific rank. There is a correctly named specimen in the old British Museum collection, and other specimens in the Stephens collection over the manuscript names *affinis* and *luteicornis ;* though these names were listed by Stephens in his catalogue, no description was ever published.

3. **Simulium reptans,** L. (figs. 1, 3, 4).

Length, 2·3–3 mm.

Male.—*Thorax* with the silvery markings rather smaller, more rounded and decidedly more brilliant than in *S. ornatum*, and with the golden pubescence much more scanty. Pleurae without the patch of hairs in front of the wing-base. *Abdomen* much as in *S. ornatum*, but less hairy ; the hair on the basal scale black. *Genitalia* (about a dozen mounts compared ; fig. 1, *c*) : claspers of slightly different shape from

those of *S. ornatum*, being somewhat narrowed towards the tip ; external part of adminiculum much longer and narrower, and its internal appendages of different form. *Legs* black, with the following exceptions : front tibiae with the usual silvery-grey patch ; middle tibiae yellowish on the basal half, with a silvery sheen, especially on the outer side ; hind tibiae pale on the extreme base ; hind metatarsi brownish on the basal half or two-thirds. Front tarsi considerably expanded, more so than in *S. variegatum* ; hind metatarsi (fig. 4, *c*) only slightly enlarged, their diameter being considerably less than that of the tibiae. Front femora not so hairy as those of *S. ornatum*.

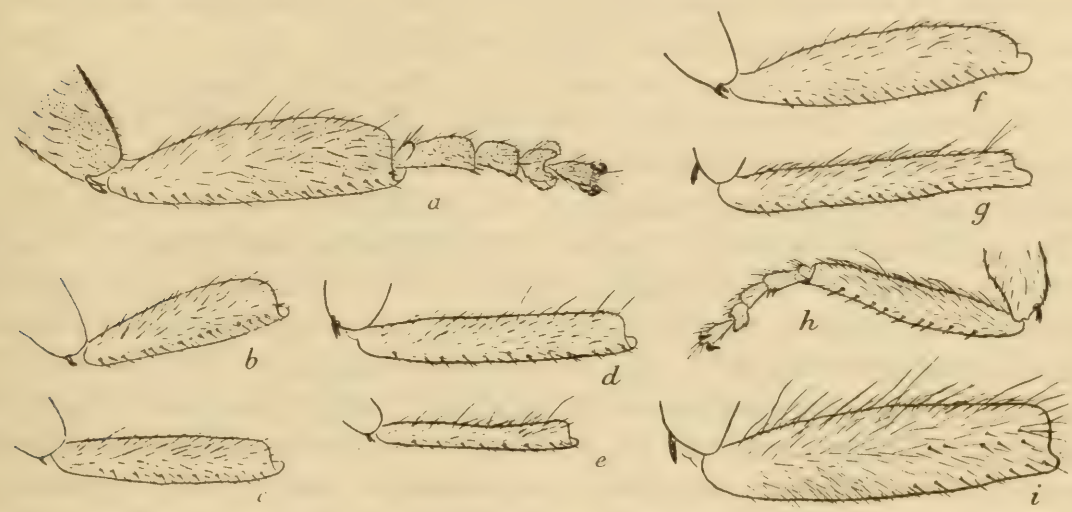

Fig. 4. Hind tarsi or metatarsal joints of *Simulium*, × 40 :—*a, S. ornatum*, ♂ ; *b, S. tuberosum*, ♂ ; *c, S. reptans*, ♂ ; *d, S. argyreatum*, ♂ ; *e, S. equinum*, ♂ or ♀ ; *f, S. latipes*, ♂ ; *g, S. latipes*, ♀ ; *h, S. angustipes*, ♂ from Nairn ; *i, S. hirtipes*.

Female.—Head : face with silvery-grey dusting, frons and vertex polished black. Antennae black, the two basal joints often indistinctly reddish. *Thorax* dull greenish black with large patches of silvery-grey dusting on the shoulders, more conspicuous in certain lights ; these patches however are not distinctly divided by transverse stripes as they are in *S. ornatum* ; the whole mesonotum clothed with fine hair-like golden pubescence, more densely so than in the male. Pleurae lacking the patch of soft hairs. *Abdomen :* hair on basal segment yellow ; second segment more or less yellowish, silvery-grey at the sides ; segments 3–5 dull black, bare ; segments 6–8 shining blackish, with fine yellowish hair. *Legs :* front pair with the coxae clear yellow ; femora almost entirely blackish brown ; tibiae yellow, black on the apical fourth, the usual patch of silvery-grey dusting present, but less conspicuous on account of the yellow ground-colour ; tarsi (fig. 3, *c*) black, very much expanded, considerably more so than in the male. Middle and hind legs : coxae black ; femora blackish, except at the extreme base ; tibiae clear yellow on the basal half or two-thirds, black at the apex ; tarsi blackish, base of mid metatarsus yellowish-brown, hind metatarsus clear yellow on the basal half or two-thirds. All the claws simple, though with well-marked basal enlargement.

Time of Appearance.—Though the dates of which I have records range from 20th May to 28th August the principal months are June and July. It is considerably later in making its appearance than *S. ornatum*, but apparently does not remain on the wing so long.

Distribution.—So far as these islands are concerned, *S. reptans* appears to be almost entirely a Scotch insect, a fact which has already been noted by Austen in his *British Blood-sucking Flies.* The following are the localities from which I have examined specimens :—SCOTLAND : Loch Assynt and Lochinver, Sutherland (*Y.*) ; Dingwall and Loch Maree, Cromarty (*K.*) ; Nethy Bridge, Spey Bridge, Corrour, Dunachton, Kincraig and Aviemore, Inverness (*G.*, *J.*, *K.*, *L.*, *Y.*) ; Ballater, Aberdeen (*J.*) ; Logie, Forres and Brodie, Elgin (*J.*, *K.*, *Y.*) ; Kinlochewe, Ross (*W. R. O. Grant*) ; Aberfoyle, Comrie and Rannoch, Perth (*Ct.*, *G.*) ; Lewis I. (*L.*) ; Hawkhead, Renfrew (*K.*) ; Gorge of Avon, Lanarks. (*K.*). ENGLAND : Bassenthwaite, Cumberland (*T. Hartley*). IRELAND : Kenmare, Kerry (*K.*) ; Cappoquin, Waterford (*K.*) ; Newcastle, Co. Down (*K.*) ; Louisburgh, Co. Mayo (*M.*).

Habits.—As is well known, this species is a troublesome blood-sucker. According to Colonel Yerbury (quoted by Austen, *British Blood-sucking Flies*), it " occurs in countless numbers in the Abernethy forest in June and July, and causes great annoyance. A sweep or two with the butterfly net round one's head results in a perfect holocaust of victims." Colonel Yerbury in his paper, *The Diptera of Wester Ross*, records it as very troublesome at Lochinver, flying in company with *Hydrotaea irritans* and biting his forehead. Mr. T. Hartley, in sending specimens to the British Museum for identification, describes it as " a terrible pest to man, dogs and cattle at Bassenthwaite." As regards the males, Colonel Yerbury has found them on flowers of yellow saxifrage at Loch Assynt.

Synonymy.—Although doubt might arise as to the interpretation of Linnaeus' *S. reptans* it is beyond question that this is the species so regarded by Meigen and Zetterstedt. Beyond this I think the names *S. elegans*, Mg., *S. posticata*, Mg., and *S. nana*, Zett., probably apply to the same species, while there is nothing in the original description of *S. argyreata*, Mg., to separate it definitely from *S. reptans*. Lundström figures the species under the name *Melusina reptans* var. *rostrata*.

4. **Simulium morsitans,** sp. n. (fig. 1).

Differs from *S. reptans* as follows :—*Male :* middle tibiae only inconspicuously, and hind metatarsi scarcely perceptibly pale at the base, the latter a little more enlarged. Claspers (fig. 1, *d*) much broader, slightly broadening out at the tip, apical spine absent ; adminiculum of quite a different form, somewhat resembling that of *S. ornatum* and *S. variegatum*. *Female :* yellow markings of legs rather less conspicuous, the hind metatarsi especially being only brownish yellow on the basal half.

The species is distinguished mainly by the characters of the male genitalia ; these organs were mounted and compared in three out of the four males examined, and their structure appeared to be constant. Too much reliance cannot be placed on the coloration.

Type ♂ in the British Museum, from Christchurch, Hants., 23.v.1897 (*Y.*).

Time of appearance.—Most of the specimens examined were taken during May or early June, but other dates are 21st April, 11th July and 13th August.

Distribution.—This seems to be the representative in the South of England of the more northerly *S. reptans*, though it also occurs in Scotland, but apparently rarely. ENGLAND : New Forest (*V.*, *Y.*) ; Christchurch (*Y.*) ; Lymington (*Dr. L. W. Sambon*) ; Enslow, Oxfordshire (*H.*) ; Cambridge (*J.*, females only) ; Fakenham, Suffolk (*N.*, females only). SCOTLAND : Aviemore (*K.*, the male figured).

Habits.—Colonel Yerbury notes : " This fly bites and annoys one in the forest."

Synonymy.—Although it is possible that one of the older names may apply to this species, it is impossible to be certain, and it therefore seems wisest to propose a new name. The species is referred to (but not named) by Austen in his *British Blood-sucking Flies*, though an examination of the series on which his remarks were based shows that though all the females are *S. morsitans*, all but one of the males are *S. austeni*.

5. **Simulium austeni,** sp. n. (fig. 1, *f*).

Differs from *S. reptans* as follows :—Male legs entirely dark blackish-brown, except for the silvery patch on the front tibiae. Claspers (fig. 1, *f*) rather longer and of a slightly different shape, and provided near the base on the inner edge with an inwardly projecting thumb-like process (this does not show up well in the figure ; it is best seen in an oblique side-view) ; adminiculum and its appendages practically the same as in *S. morsitans*. Female (if correctly identified in a single specimen from Barnham) with the pale markings rather less distinct even than in *S. morsitans*.

The difference in the form of the male claspers is quite sufficient to distinguish *S. austeni* specifically from *S. morsitans*. About 8 mounts of the genitalia were compared, and many others examined in the dry state. There was no observable variation. Possibly when more females are discovered better characters can be adduced for the separation of that sex from *S. reptans* and *S. morsitans*.

Type ♂ in the British Museum, from Rugby, 23.iv.1893 (*E. E. Austen*).

Time of appearance.—The dates of capture of the specimens examined range only from 23rd April to 22nd May.

Distribution.—ENGLAND : West Moors, Dorset (*Y.*) ; Rugby (*E. E. Austen*) ; Shotover and Lye Hill, Oxford (*H.*) ; Cambridge (*J.*) ; Barnham, Suffolk (*N.*) ; Felden, Herts. (*P.*).

Habits.—Austen found the males " dancing in a swarm in the afternoon by a gate in a field."

Synonymy.—The same remarks apply to this species as to *S. morsitans*. I at first confused it with *S. tuberosum*, but the two are really quite distinct.

6. **S. tuberosum,** Lndst. (figs. 1, 2, 4).

Differs from *S. reptans* as follows :—*Male :* legs entirely black ; hind metatarsus (fig. 4, *b*) considerably more thickened ; no distinct silvery-grey margin to the mesonotum, though the shoulder-spots are well-marked. Genital claspers (three mounts compared ; fig. 1, *e*) resembling those of *S. austeni*, but more slender and slightly widened towards the tip ; the internally projecting thumb-like process near the base well developed, but not so broad as in *S. austeni ;* adminiculum with its ventral portion very short and broad, its internal appendages smaller and less complicated than in

other members of this group. *Female:* face polished black, like the frons; antennae all black; thorax without any trace of silvery grey shoulder-patches; abdomen entirely black, the tergites of segments 6–8 rather smaller and less noticeably shining; legs black, except that the front tibiae have the usual silvery patch, and the bases of the entirely middle and hind tibiae are rather indistinctly brownish yellow; the front tarsi not quite so much expanded as in *S. reptans*.

Apart from the above distinctions, *S. tuberosum* seems to be consistently though only slightly smaller than *S. reptans*.

Time of appearance.—Dates range from 14th May to 14th August, while a few females were also taken on 13th November.

Distribution.—This is another purely northern or mountain species. SCOTLAND: Loch Maree, Ross (*K.*); Loch Assynt, Sutherland (*Y.*); Dingwall, Cromarty (*K.*); Kincraig, Nethy Bridge and Aviemore, Inverness (*G.*, *K.*, *Y.*); Ardochy, Invergarry, Inverness (*E. C. Ellice*). ENGLAND: Bassenthwaite, Cumberland (*T. Hartley*).

Habits.—Mr. T. Hartley has sent specimens of this species to the British Museum, together with those of *S. reptans*, with the information that they were "a terrible pest to man, dogs and cattle." He also writes (June 1913) that "it is only within the last three years that it has been troublesome, but now is becoming a perfect plague." Similarly Mr. E. C. Ellice writes that it is "locally known as 'the Black Fly.' It is a pest, and from being almost unknown—I think quite unknown—30 or 40 years ago, has increased year by year in the district." In this connection it may be significant that there are no specimens in any of the old collections in the British Museum.

Synonymy.—Through the kindness of Dr. R. Frey, of Helsingfors, I have been able to examine one of the late Prof. Lundström's original specimens, which agrees in every respect with ours, so that the identification is beyond doubt. Some of the British Museum specimens were determined by M. Roubaud as *S. nigrum*, Mg., but I cannot follow this. Meigen drew up his description from two males, and, inadequate though it is, the absence in it of any reference to silvery markings on the thorax, must I think definitely exclude the present species.

7. **Simulium argyreatum,** Mg. (Lndst.). (figs. 1, 2, 4).

Length, 2·2–3 mm.

Male.—Silvery markings of *thorax* more crescent-shaped and rather less distinct than in the four species last considered; in some specimens they are produced backwards as two greyish lines as far as the posterior greyish border of the mesonotum, and in those specimens the mesonotum might be described as greyish with three broad velvet-black stripes. The pubescence of the mesonotum is so very short and fine that it is scarcely visible under a hand-lens, though in the specimens with the grey-striped thorax it seems to be a little more noticeable; this may be due merely to the larger size of these specimens. Pleurae with a small patch of soft hair between the prothoracic stigma and the wing-base (at least in some specimens). *Abdomen* velvet-black with the usual silvery-grey side-spots on segments 2, 5 and 6; the hair on the basal segment black. *Genitalia* (three mounts compared; fig. 1, *g*) very characteristic, the claspers short, squarish, and provided with 5 or 6 short spines along

their terminal edge, instead of only one (these do not show in the figure). *Legs* black, except for the silvery patch on the front tibiae, and the hind metatarsi, which are dull yellowish, except at the tip and the extreme base. Front femora with only a little short hair; front tarsi slightly expanded; hind metatarsi almost cylindrical (fig. 4, *d*).

Female.—Head : frons and vertex shining black; face silvery grey; antennae all black. *Thorax* with integument of mesonotum somewhat shining, with a sub-metallic greenish hue, and clothed with a very fine yellowish pubescence, finer than in the other species of this group; viewed from in front the thorax has indications of two rather broad greyish stripes which are somewhat divergent posteriorly, but there are no shimmering grey shoulder patches. Pleurae with a small patch of hairs as in the male; these hairs are less conspicuous than in *S. ornatum* or *S. equinum*. *Abdomen* black, second segment silvery grey at the sides; hair on basal segment yellowish; tergites of last three segments very large and markedly shining (thus distinguishing it from the female of *S. tuberosum*, with which it might perhaps be confused). *Legs :* front pair black, the coxae and the tibial patch conspicuously silvery grey, the tarsi about as much enlarged as in *S. reptans*. Middle and hind legs black, the femora and tibiae more or less reddish towards the base; the hind metatarsi yellowish, except for the tip, the extreme base, and a line along the under side. Claws (fig. 2, *b*) all simple, as in *S. reptans*.

Time of appearance.—This seems to be a spring species, common in April, May and early June, and appearing again in August. One specimen in the British Museum series was taken on 1st November.

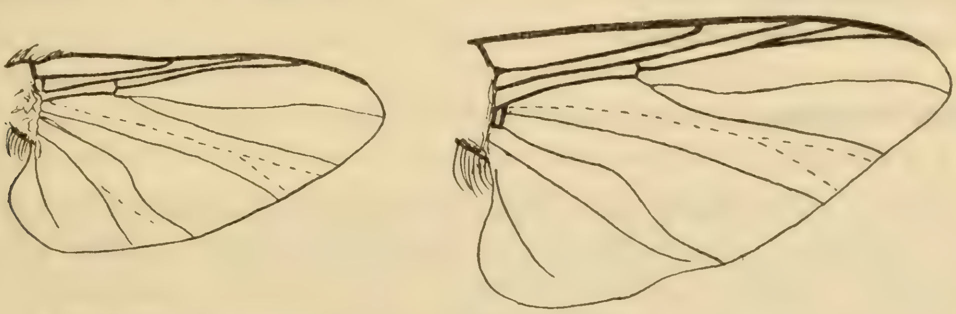

Fig. 5. Wings of *Simulium*, × 13; left: *S. latipes*; right: *S. hirtipes*.

Distribution.—Essentially a lowland species, with its headquarters apparently in East Anglia. ENGLAND : Bourne End, Bucks., and Felden, Herts. (*P.*); Sandy, Beds. (*E.*); Cambridge (*J.*); Newmarket and Chippenham, Cambs. (*V.*); Barton Mills, Bungay, Suffolk (*V.*); and Brandon (*M.*), Ampton, Fakenham and West Stow, Suffolk (*N.*); Wood Walton Fen, Hunts. (*E.*); Sherwood Forest and West Leake, Notts. (*Cr.*). SCOTLAND : Bonhill and Helensburgh, Dumbarton (*K.*).

Habits.—This is evidently an habitual blood-sucking species. The writer was besieged by a large swarm of females on Sandy Heath, many attempting to bite and some actually doing so. Mr. J. C. F. Fryer informs me that it is very troublesome in spring and again in August on Wood Walton Fen and also at Wicken. In these localities it is worthy of note that there is no running water anywhere in the neighbourhood.

Synonymy.—Although I consider it very doubtful whether this is really Meigen's *S. argyreatum,* I have followed Lundström in so interpreting it, as I am not acquainted with another available name. The species stood in Mr. Verrall's collection as *S. nigrum,* Mg., and so it may possibly be, but I prefer to leave this name a *nomen dubium.* *S. nanum,* Zett., is given as a synonym of *S. argyreatum* in the Palaearctic Catalogue, but I believe it is more likely to be a small *S. reptans.* The specimens recorded by Verrall as *S. nanum* from Tuddenham are apparently small examples of this species, in which the legs are paler than usual. From the description I very much suspect Meigen's *S. sericatum* may be this species, though in the Palaearctic Catalogue it appears as a synonym of *S. ornatum.*

Group B.

Table of Species.

1. Pubescence distinctly deep or light golden ; second hind tarsal joint with deep excision	2
Pubescence whitish or dull yellowish ; second hind tarsal joint entire or emarginate	4
2. Hind metatarsi largely pale	*equinum*
Hind metatarsi entirely dark	3
3. Hind metatarsi of male much enlarged ; femora and tibiae of female more or less uniformly dark	*latipes*
Hind metatarsi of male not enlarged ; femora and tibiae of female yellow with black tips	*aureum, angustipes*
4. Radial sector of wings simple	*subexcisum*
Radial sector of wings forked	*hirtipes*

8. **Simulium equinum,** L. (figs. 1, 2, 3, 4, 6).

Length, 2·5–3·5 mm.

Male.—*Thorax* velvet-black, the margins of the mesonotum more or less greyish, but without any silvery sheen ; pale golden pubescence on the shoulders and in front of the scutellum (possibly perfect specimens may have the mesonotum uniformly clothed with this pubescence). Pleurae with a well-marked patch of hair between the prothoracic stigma and the wing-base. *Abdomen* velvet-black, with yellowish hair. *Genitalia* (fig. 1, *h*) with the side-pieces large ; claspers small, thin, curved, projecting internally when at rest. *Legs* black ; knees of the middle and hind legs narrowly yellowish ; hind metatarsi (fig. 4, *e*) mainly yellow on the basal half, almost cylindrical ; front tarsi quite thin, the metatarsi cylindrical ; femora and tibiae, especially of the front legs, with a coarse pale golden pubescence. *Halteres* yellow.

Female.—*Head* dull grey, sparsely clothed with coarse pale golden pubescence ; antennae dark brown, the two basal joints reddish. *Thorax* light or dark grey with three narrow but rather ill-defined blackish longitudinal lines, the lateral pair convergent anteriorly, and also immediately before the scutellum ; in very dark specimens these lines are obsolete, in very light ones an additional and broader pair appear at the sides of the mesonotum. The whole dorsum of the thorax is clothed with coarse pale golden pubescence, which is, however, very easily rubbed off. Pleurae with the patch of hair as in the male. *Abdomen* black (in dried specimens), rather

densely clothed with a similar pubescence to that of the thorax; there is however even in perfect specimens a narrow transverse bare band at the base of each segment. *Legs* (fig. 3, *d*, front tarsus) as in the male, but sometimes with the femora and tibiae much more extensively pale towards the base. Claws (fig. 2, *e*) much larger in proportion to the size of the insect than in any other species of the genus; they are quite simple and not very much enlarged at the base; as if to compensate for the enlarged claws, the empodia are reduced in size. *Halteres* yellow.

Time of appearance.—Continuously from early March till September; one specimen in the British Museum was captured on 28th October.

Distribution.—A common species in many districts in the South of England; less common in the north, and apparently unknown in Scotland. I have examined specimens from the following localities: ENGLAND: Padstow, Cornwall (*L.*); Taunton (*Miss B. K. Taylor*); Wareham, Arne and Wimborne, Dorset (*Y.*, *M.*),; Christchurch, Lymington and Brockenhurst, Hants. (*J.*, *K.*, *L.*, *V.*, *Y.*); Darenth, Kent (*V.*); Oxshott, Surrey (*H. Donisthorpe*); Weybridge (*V.*); Felden and Bricket Wood, Herts. (*P.*); Barton Mills, Suffolk (*V.*), Ampton, Barnham, Icklingham, Timworth and West Stow, Suffolk (*N.*); Eynsham, Norfolk (*V.*); Oxford (*H.*); Attenborough, Beeston, Clifton, Edwinstowe, Gotham, Radcliffe and West Leake, Notts. (*Cr.*, *Y.*); Netheravon, Wilts. (*Capt. E. P. Argyle*); Wilton (*J.*); Grimshill, Salop. (*L.*); Burley in Wharfedale (*G.*); Holmes Chapel, Cheshire (*A. E. Cameron*); Great Salkeld, Cumberland (*H. Britten*). WALES: Llandrindod Wells (*E. Brunetti*). IRELAND: Killaloe, Co. Clare (*M.*); Cappoquin, Co. Waterford (*K.*).

Habits.—This fly is a blood-sucker, and seems to have a partiality for horses. Specimens were sent to the British Museum at different times by Colonel L. J. Blenkinsop and Captain E. P. Argyle as having been taken on horses' ears. The former observer wrote that "these flies are troubling horses here [near Salisbury and near Christchurch] by sucking blood from their ears and causing ulceration." Outside Britain its habits appear to be the same; Captain C. E. P. Fowler has found it in Morocco "swarming around gardens and marsh outside Fez; attacks horses about ears." *S. hippovorum*, Malloch, from Mexico, which is probably a near ally of this species, has been recorded as having the same habit. *S. equinum* also attacks man; Mr. Hamm has observed that it bites quite severely. The females have more than once been taken flying in company with those of *S. ornatum* (*vide* notes under the latter species).

Mr. H. Britten* has observed the oviposition of this species. He noticed the females enter the water and deposit eggs actually on the submerged parts of plants. This habit appears to be unusual, as it has not been recorded for any other species; it may possibly be correlated with the unusually large claws.

Synonymy.—From the apparently definite connection of this species with horses, I think it may be safely considered to be Linnaeus' *Culex equinus*, which has always been assumed to be a species of *Simulium*, while his short description corresponds better with this species than with any other. Linnaeus simply describes the thorax as black, with greyish sides (*i.e.* pleurae, presumably); as already mentioned, specimens with a blackish mesonotum are not uncommon, and in these the three stripes

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* Ent. Mo. Mag., May, 1915.

are indistinct; the mention by Linnaeus of the head being white above and below the eyes, together with the legs being black, will definitely exclude all the species of our Group A. Zetterstedt suggested that *C. equinus* might be the same as *S. fuscipes*, Fries (which is undoubtedly the species now under consideration), though he does not say he had noticed any connection between *S. fuscipes* and horses, merely remarking: "Femina fortiter mordens."

The species is listed in the Palaearctic Catalogue and in Verrall's List of British Diptera as *S. maculatum*, Mg., and this is probably correct, in spite of the fact that Meigen described the abdomen as spotted with black, which is not the case in dry specimens. Of the other names which are commonly placed as synonyms of *S. maculatum*, *S. fuscipes*, Fries, *S. marginatum*, Mg., and *S. pubiventris*, Zett., are doubtless correctly so given; but whatever *S. columbaschense*, Fabr., and *S. lineatum*, Mg., may be, they are certainly not this species, the former having pale tibiae and tarsi, and the latter having the "hinterleib braün, *hinten glanzend*," and the "*schienen alle weisschillernd*." Macquart's *S. pubescens* and *S. cinereum* are in all probability our *S. equinum*. Some of the specimens in the British Museum collection have been determined by Verrall and Roubaud as *S. lineatum*, Mg. Lundström determined the species as *S. aureum*, Fries, but I feel sure he was wrong in this, since if the hind metatarsi had been pale in Fries' specimens, that author would almost certainly have mentioned the fact.

9. **Simulium latipes,** Mg. (figs. 1, 2, 4, 5).

Length, 2·3–3·5 mm.

Male.—Thorax velvet-black, more or less densely clothed with golden pubescence. Pleurae bare. *Abdomen* velvet-black, with yellowish hair on the basal segment. *Genitalia* (fig. 1, *m*): side-pieces large; claspers also large, and with a peculiar twist, the apical part (bearing as usual one short spine) being truncate and bent inwards (the figure is taken from a mounted specimen, about a dozen of which have been compared); in a dry specimen the tip of the clasper is usually not visible in a ventral view. *Legs* dark brown, tarsi blackish; the integument uniform in colour, though the front tibiae often appear silvery and the base of the middle and hind tibiae golden-yellow, owing to the colour of the pubescence; the long hairs, which are fairly numerous on the hind legs, are dark; hind metatarsi (fig. 4, *f*) very much flattened, their diameter usually about as great as that of the tibia, though there is some variation in this respect. *Wings* as in the figure (fig. 5, *a*), the venation being the same as that of all the other British species, with the exception of *S. hirtipes*. *Halteres* brownish yellow.

Female.—Head grey, with golden pubescence; antennae black with the two basal joints reddish. *Thorax* blackish grey, in perfect specimens densely clothed with coarse bright golden pubescence; pleurae bare. *Abdomen* equally densely clothed with similar pubescence; the integument usually dark, but sometimes reddish, except for the small tergal plates which remain dark. *Legs:* femora and tibiae dark brown, more or less distinctly paler towards the base, the middle and hind tibiae in the lightest specimens with a dark ring at or near the base; pubescence golden. Tarsi black; the hind metatarsi (fig. 4, *g*) sometimes brownish, very little thickened. Claws (fig. 2, *c*) with a large blunt tooth projecting from the base. *Halteres* lighter than in the male.

Time of appearance.—From early April till the beginning of September, but commonest apparently in April and May.

Distribution.—This is probably the commonest species of the genus all over the British Islands, though it may often be overlooked. The following list includes most of the localities from which I have examined specimens, but I have not kept a note of all :—ENGLAND : Helston, Padstow and Downderry, Cornwall (*L.*, *V.*, *Y.*) ; Bovisand, S. Devon (*Y.*) ; New Forest (*Y.*) ; Corfe Castle, Dorset (*Y.*) ; Cusop, Hereford (*Y.*) ; Stokenchurch, Oxford (*V.*) ; Oxford (*H.*) ; Crowborough, Sussex (*J.*) ; Burnham Beeches and Fulmer, Bucks. (*E.*) ; Harrow Weald and Ruislip, Middlesex (*E.*) ; Ampton, Livermere and Timworth, Suffolk (*N.*) ; Orford, Suffolk (*K.*) ; Kirtling, Cambs. (*V.*) ; Cambridge (*J.*) ; Burley in Wharfedale (*G.*). WALES : Porthcawl, Glamorgan (*Y.*). SCOTLAND : Glencorse and Blackford Hill, Edinburgh (*G.*, *J. Waterston*) ; Hunter's Quay and Ardentinny, Argyll (*K.*) ; Arrochar, Bonhill, Helensburgh and Luss, Dumbarton (*K.*) ; Braidwood and Gorge of Avon, Lanarks. (*K.*) ; Hawkhead, Renfrew (*K.*) ; Dalry, Ayr (*K.*) ; Auchenbowie, Stirling (*J.*) ; Aberfoyle, Blairgowrie, Loch Gill and Loch Tay, Perth (*Ct.*) ; Benbecula (*N. B. Kinnear*) ; Aberdour, Aberdeen (*G.*) ; Aviemore, Ballindalloch, Corrour, Dunachton, Kincraig, Nethy Bridge, Newtonmore and Spey Bridge, Inverness (*G.*, *J.*, *L.*, *Y.*) ; Nairn (*Y.*) ; Logie, Elgin (*J.*) ; Kinlochewe, Ross (*W. R. O. Grant*) ; Dingwall, Cromarty (*K.*) ; Loch Maree (*K.*) ; Loch Assynt, Sutherland (*Y.*). IRELAND : Sligo (*K.*) ; Newcastle, Co. Down (*K.*) ; Cappoquin, Co. Waterford (*K.*).

Habits.—Nothing has been recorded, except that Colonel Yerbury has found the males hovering in a flock in the shade. In view of the commonness and wide distribution of the species, the absence of any records of its biting would seem to prove that it is not a blood-sucker.

Synonymy.—This has always been assumed to be Meigen's *S. latipes*, and I see no particular reason to doubt that it is so. *S. aureum*, Fries, has often been quoted as a synonym, but I believe wrongly ; the same applies to *S. auricoma*, Mg., which appears to me from the description to be *S. ornatum*.

10. **Simulium aureum,** Fries, (fig. 1, *i*).

Differs from *S. latipes* as follows :—Hind metatarsi thin in both sexes ; male genital claspers (fig. 1, *i*) much thinner and not twisted ; adminiculum differently constructed (four mounts compared) ; femora and tibiae of female yellow with black tips ; of the male somewhat lighter towards the base.

Time of appearance.—The dates of capture of the small number of specimens I have seen range from 31st March to 15th August.

Distribution.—Apparently a rare species, occurring with *S. latipes*, to which it is closely allied. In the following list of localities those only are given from which I have seen male specimens, as I know of no reliable character to distinguish the females from those of *S. latipes* or *S. angustipes*. ENGLAND : Mildenhall, Suffolk (*Y.*) ; Foxhall, nr. Ipswich (*M.*) ; Cambridge, in house (*J.*). WALES : Porthcawl, Glamorgan (*Y.*).

Habits.—Probably identical with those of *S. latipes*.

Synonymy.—I think this species must be correctly named, as it fits Fries' description very well indeed. It is evident that *S. aureum* has been wrongly sunk under *S. latipes* ;

Fries himself recognised the affinity of the two species, but called attention to the difference in the size of the hind metatarsi of the male. Lundström, through a mistaken interpretation of Fries' species, and through not having recognised the females of either, has redescribed the true *S. aureum* as *S. angustitarsis*. Meigen's *S. rufipes* may be another synonym, but even if that is so Fries' name takes precedence. A female in Stephens' collection under the manuscript name *flavipes* seems to belong to this species.

11. **Simulium angustipes,** sp. n. (figs. 1, 4).

Differs from *S. latipes* as follows :—Hind metatarsi (fig. 4, *h*) thin in both sexes; middle and hind tibiae of the male with the integument more or less distinctly yellow at the base; female legs rather paler, especially on the front tibiae; male genitalia (fig. 1, *j*, *k*, *l*) different, the claspers much smaller and usually with a somewhat hammer-shaped tip; adminiculum somewhat hairy and though variable in size quite different in form from that of *S. latipes* or *S. aureum*; *appendices superae* much larger and very conspicuous in a dry specimen.

Like the last, this is a near ally of *S. latipes*, differing from it principally in the male genitalia, the structure of which, especially as regards the *appendices superae*, is not unlike what is figured by Lundström as *S. pallipes*, Fries. It is the only British species in which I have seen any appreciable variation in the genitalia. The adminiculum is always hairy, but though very thin in the Barton Mills specimens, it is a good deal thicker in most of the others, including those figured. The claspers, though usually with a small projecting hump at the tip, are quite simple at the tip in specimens from Crowborough and Logie, as well as being a little shorter ar d thicker than usual. The *appendices superae* are also somewhat variable in shape and in the number of hairs they carry. None of these variations however seem to be sufficiently definite to be regarded as of specific value, and none of them make any approach towards *S. aureum* or *S. latipes*.

In general characters also there is some variation; in the specimens from Nairn, Cambridge and Crowborough the middle and hind tibiae are not any paler at the base; while in those from Padstow, Logie and Sligo the hind metatarsus is distinctly thicker than usual, though much less expanded than in *S. latipes*.

Type ♂ in the British Museum from Barton Mills, 3.v.1909 (*C.*).

Time of appearance.—March to October.

Distribution.—Like *S. aureum*, this seems to be mainly a lowland or coast species, often associated with *S. latipes*. England : Padstow, Cornwall (*L.*); Wells, Somerset (*L.*); Crowborough, Sussex (*J.*); Cambridge (*J.*); Barton Mills, Suffolk (*C.*); Walton-on-Naze, Essex (*Y.*). Scotland : Nairn (*K.*); Logie, Elgin (*J.*). Ireland : Sligo (*K.*).

Habits.—Probably similar to those of *S. latipes*. Colonel Yerbury notes that he found the males hovering in twos and threes in the shade.

Synonymy.—As this species is not included by Lundström in his account of the Finnish species, it is not likely that it is the true *S. aureum*, Fries, and that being so there appears to be no old name available for it. There is a specimen in the old Clifton collection in the British Museum labelled *S. sericeum*.

12. **Simulium subexcisum,** sp. n. (figs. 1, 2, 3, 6).

Length, 2·2–3 mm.

Male.—Thorax velvet-black, with yellowish, not deep golden pubescence (in the two specimens examined the mesonotum was much denuded); scutellum with yellowish hair which is longer than usual. Pleurae bare. *Abdomen* velvet-black, hair on the basal segment yellowish. *Genitalia* (two mounts compared: fig. 1, *n*): side-pieces large; claspers roundish in section, tapering towards the tip, somewhat curved, with a single short spine at the tip; adminiculum as in the figure. *Legs* uniformly blackish, with coarse yellowish pubescence, except on the tarsi; front femora and hind femora and tibiae with long dark hair, which is denser on the hind tibiae than in any other British species except *S. hirtipes* (one of the specimens is denuded). Front tarsi thin, cylindrical; hind metatarsi distinctly thickened, though not so much so as in *S. latipes*. Second hind tarsal joint (fig. 6, *c*) with only an irregular emargination at the base, not a definite excision as in the eleven preceding species. *Wings* with normal venation. *Halteres* blackish.

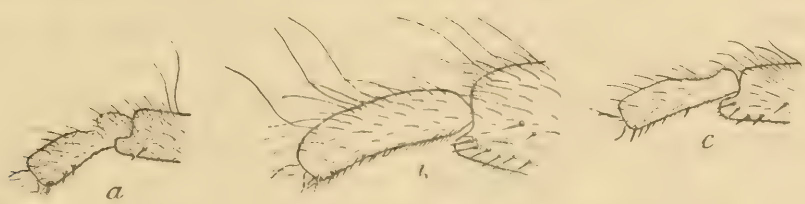

Fig. 6. Tip of metatarsus and whole of second tarsal joint of: *a, Simulium equinum*; *b, S. hirtipes*; *c, S. subexcisum*; × 60.

Female.—Head clothed with coarse yellowish pubescence; face yellowish grey; frons greyish below, darker and slightly shining above, narrower than in the other species. Antennae all black. *Thorax* dull blackish-grey, the mesonotum densely clothed with coarse pubescence, which is sometimes uniformly yellowish, sometimes however showing three broad longitudinal stripes of dark brown.* *Abdomen* dark, densely clothed with coarse yellowish pubescence. *Legs* (fig. 3, *e*, front tarsus) entirely dark brownish-black; less hairy than in the male; hind metatarsi not thickened; second hind tarsal joint as in the male; claws (fig. 2, *f*) much resembling those of *S. latipes* and its allies. *Halteres* yellow.

Type ♂ in the Cambridge Museum, from Crowborough, Sussex, 9.iv.1904 (*J.*).

Time of appearance.—April to June.

Distribution.—Though widely distributed, apparently a rare species, as I have not seen more than four specimens from any one locality. England: New Forest (*D. Sharp, Y.*); Crowborough, Sussex (*J.*); Harrow Weald, Middlesex (*E*); Tarrington, Hereford (*Y.*). Scotland: Aviemore, Dunachton and Nethy Bridge (*G., Y.*); Nairn (*Y.*); The Mound, Sutherland (*Y.*).

Habits.—Nothing recorded.

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* It is possible that these two forms of the female may represent distinct species, but there are no structural differences.

Synonymy.—The male genitalia bear a rather close resemblance to Lundström's *S. lyra* and *S. annulus*, but the agreement is not complete, and as he stated that he could detect no external difference between his species and *S. latipes*, I think it best to regard our species as previously undescribed. Examples of Lundström's species kindly given me by Dr. Frey unfortunately both lacked the hind tarsi, which, apart from the genitalia, carry the most important specific distinctions.

13. **Simulium hirtipes,** Fries, (figs. 1, 4, 5, 6).

Length, 3–4·5 mm.

Male.—*Thorax* dull blackish, the mesonotum clothed rather densely with coarse yellowish pubescence ; long yellow hair on the scutellum and the posterior part of the mesonotum. *Abdomen* dull black, with long dark hair on the basal segment and on the venter, short yellowish hair on the tergites. *Genitalia* (fig. 1, *o*): the claspers differ from those of all the other British species in having two short spines at the tip (one clasper in the specimen figured was abnormal in having three such spines). *Legs* uniformly dark, the femora and tibiae clothed with yellowish hair, which on the hind legs is very long and dense ; hair on tarsi darker. Joints of front tarsi cylindrical, but the metatarsus not so long as in *S. latipes*. Hind metatarsi (fig. 4, *i*) very much thickened, in diameter about equal to the tibiae ; only a very indistinct projection on the inner side at the tip. Second hind tarsal joint (fig. 6, *b*) simple, no sign of basal excision or emargination. *Wings* (fig. 5, *b*) with a slight brownish tinge, the radial sector forked, and a minute "basal cell" present (these two characters, like those of the hind tarsi, differentiating *S. hirtipes* from all the others in the British fauna). *Halteres* black.

Female.—Head, thorax and abdomen dull blackish-grey, with pale yellowish pubescence. *Legs* entirely dark ; yellowish pubescence, but few or no long hairs, on the femora and tibiae ; hind tibiae and metatarsi, especially the latter, much more slender than in the male ; second hind tarsal joint as in the male. Claws simple, resembling those of *S. reptans*. *Wings* as in the male. *Halteres* dark brown.

Time of appearance.—May to July.

Distribution.—Another purely northern species, of which I have the following records :—Scotland : Blairgowrie and Dunkeld, Perth (*Ct.*, *Y.*) ; Aviemore, Ballindalloch and Nethy Bridge, Inverness (*G.*, *K.*, *L.*, *Y.*) ; Braemar, Aberdeen (*V.*) ; Dingwall and Loch Maree, Cromarty (*K.*) ; Loch Assynt, Sutherland (*Y.*).

Habits.—Colonel Yerbury (quoted by Austen, *British Blood-sucking Flies*) has observed the blood-sucking habits of this species at Dunkeld.

Synonymy.—There is little to remark, except that although Fries' figure does not show the forked radius, the species is without doubt correctly identified. A specimen exists in Stephens' collection with the manuscript name *picipes*.

ON A NEW SPECIES OF *LECANIUM* FROM NORTHERN NIGERIA.

By E. E. Green, F.E.S., F.Z.S.

Lecanium catori, sp. nov.

Adult female reddish or brownish ochreous with a dark marginal zone, to uniform dark castaneous. Broadly oval to subcircular ; flat ; margin evenly rounded, without trace of stigmatic clefts (fig. 1, *a*). Anal cleft completely fused, its position marked by a slight ridge and thickening of the derm. Anal operculum approximately central, the distance from posterior margin of body to anterior extremity of operculum being equivalent to nine-twentieths of the total length. Valves of operculum (fig. 1, *d*) elongate ; basal edge nearly twice as long as outer edge ; inner edge more than twice the length of the outer edge. Antenna (fig. 1, *c*) 7-jointed : formula, 3, 7, (2, 4), 5, 6, or (3, 4, 7), 2, 5, 6. In some examples there are traces of a division in the third joint.

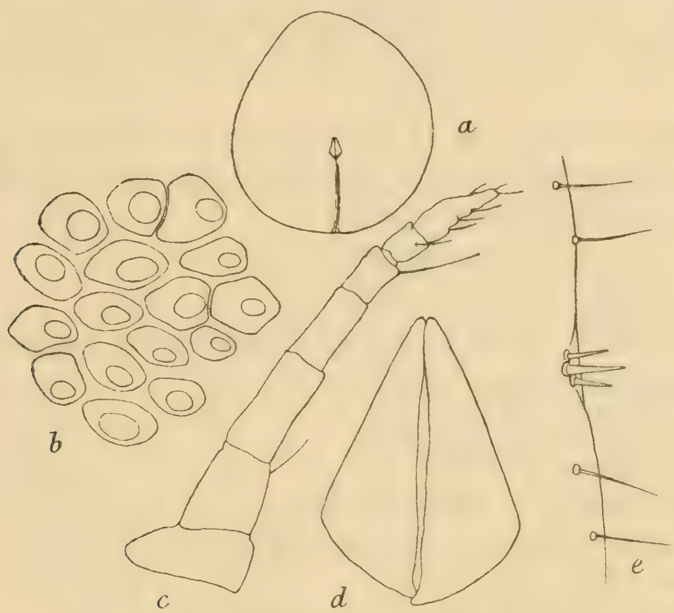

Fig. 1. *Lecanium catori*, Green, sp. n. ; *a*, adult female ; *b*, cells on the derm ; *c*, antenna ; *d*, valves of operculum ; *e*, dorsal margin.

Limbs rather slender : tarsus approximately three-quarters length of tibia : ungual digitules moderately dilated. Margin (fig. 1, *e*) with a series of longish finely pointed hairs, set at a distance from each other rather less than their own length. Stigmatic spines sharply pointed, shorter than the marginal hairs, placed almost directly on the margin. Derm closely set with large irregularly oval cells (fig. 1, *b*), with a tendency towards a polygonal outline where they are more crowded : each cell containing a large translucent subcentral spot. The cells are more sharply defined on the marginal zone : on the median area their outline becomes obscure, but the translucent nuclear spots remain conspicuous.

Length, 3–4 mm. ; breadth, 2·50–3·25 mm.

Nigeria : Kabba Province, on kola-nut pods, ii.1914 (*D. Cator*).

The same pods were thickly infested by *Stictococcus sjöstedti*, Ckll.

NOTES ON COCCIDAE COLLECTED BY F. P. JEPSON, GOVERNMENT ENTOMOLOGIST, FIJI.

By E. E. Green, F.E.S., F.Z.S.

The collection contained no new species ; but, as little is known of the Coccidae inhabiting the Fiji Islands, it will be useful to place the names on record.

The bulk of the collection consisted of examples of an *Aspidiotus* of a form intermediate between *destructor* (Mask.) and *transparens* (Green). It departs from typical *destructor* in having more prominent median lobes, but these are not so strongly chitinised as are those of typical *transparens*. After examination of copious material, from various parts of the Tropics, I am inclined to consider these two supposed species as extreme forms (in opposite directions) of the same insect. Intermediate forms, which it is impossible to assign with confidence to either name, are by far the most abundant. I now solve the difficulty by calling them all *Aspidiotus destructor-transparens* (Mask., Green). This species infests *Musa, Persea,* and *Piper,* in Fiji.

Aspidiotus excisus, Green. It is interesting to find this well-marked species (hitherto recorded from Ceylon only) occurring upon *Musa* in Fiji. The examples were found upon the skin of banana fruits.

Other species sent to me by Mr. Jepson were :—

Aspidiotus cyanophylli, Sign., on *Musa.*

Aspidiotus palmae, Ckll., on *Musa* and an undetermined forest tree.

Aspidiotus lataniae, Sign., on *Citrus.*

Aspidiotus hartii, Ckll., on *Dioscorea.*

Chionaspis citri, Comst., on *Citrus.*

Chionaspis dubia, Mask., on *Adiantum* fern.

Hemichionaspis minor, Mask., on foliage of Eucharis Lily.

Diaspis pentagona, Targ., on *Hibiscus.*

Lecanium (*Saissetia*) *nigrum,* Nietn., on *Anthurium.*

Asterolecanium miliaris-longum, Green, on *Schizostachium* (a Bamboo).

NEW SPECIES OF COCCIDAE FROM AUSTRALIA.

By E. Ernest Green, F.E.S., F.Z.S.

Eriococcus serratilobis, sp. nov. (fig. 1).

Ovisac white, strongly convex, broadly oval, narrower behind; very closely felted and tough. Length, 3·0 to 3·50 mm. Breadth, 2·25 to 2·50. mm.

Adult female broadly oval. Antenna (fig. 1, *b*) 6-jointed; 3rd joint longest; 6th almost equal to 3rd; antennal formula 3, 6, 2, (4, 5). Legs well developed; tarsus as long as or longer than tibia; tarsal digitules dilated and spatulate (fig. 1, *c*); ungual digitules hair-like, minutely knobbed. Claw with a minute denticle close to the point. Anal lobes (fig. 1, *a*) broad; irregularly conical; densely chitinous; the inner edge deeply serrate or pectinate throughout its whole length; bearing at the apex a longish slender spine followed by a long stout seta; two stout spines

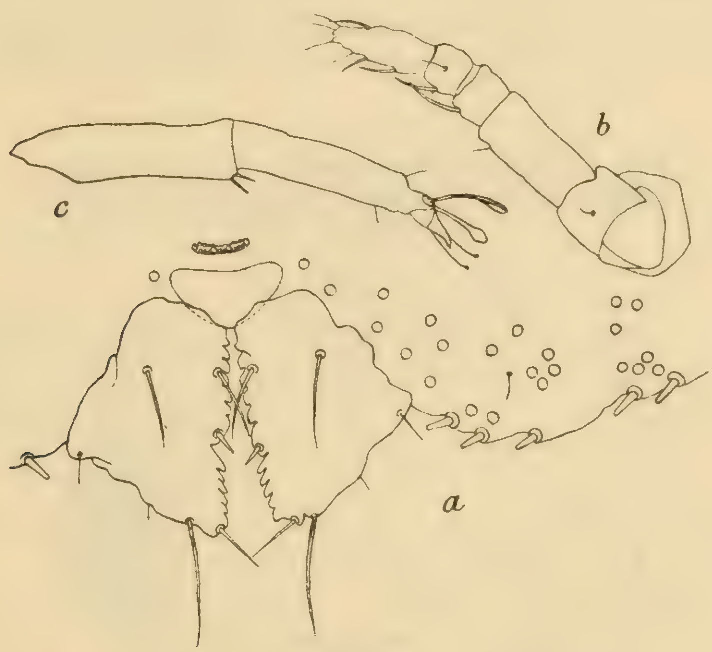

Fig. 1. *Eriococcus serratilobis*, Green, sp. n.; *a*, posterior extremity of adult female, × 210; *b*, antenna, × 210; *c*, part of mid leg, × 210.

on the inner edge and a setiform spine on the ventral face. There is a densely chitinous semicircular plate at the base of the lobes, situated dorsally. Margin of body with a complete series of truncate conical spines. No spines on other parts. Derm with numerous conspicuous circular pores, which are cup-shaped in profile. Length averaging 1·50 mm. Breadth, 1·25 mm.

Victoria: Mallee, on *Eucalyptus gracilis* (*C. French*, No. 142).

I would draw attention to the peculiar character of the digitules in this species. It is unusual to find dilated digitules in this genus, and it is still more unusual (if not unique) for the dilated members to be those of the tarsal joint. When one pair of digitules is dilated, it is almost invariably the unguals that display this character.

Eriococcus serratilobis prominens, subsp. nov. (fig. 2).

Differs from typical *serratilobis* in the form of the anal lobes (see fig. 2), which are more prominent and cylindrical, scarcely broader at the base than at the truncate extremity, contrasting strongly with the shorter and broadly conical lobes of the type. The chitinous plate at the base of the anal lobes, in this form, is narrower and more lunate in shape.

QUEENSLAND: Townville, on undetermined plant (*W. W. Froggatt*, No. 363).

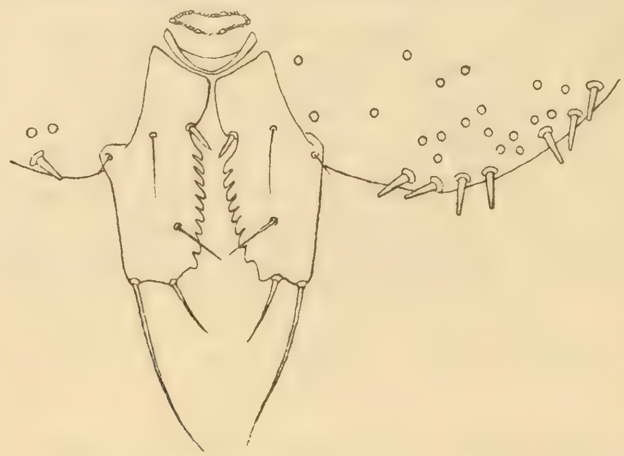

Fig. 2. *Eriococcus serratilobis* var. *prominens*, Green, nov.; posterior extremity of adult female, × 210.

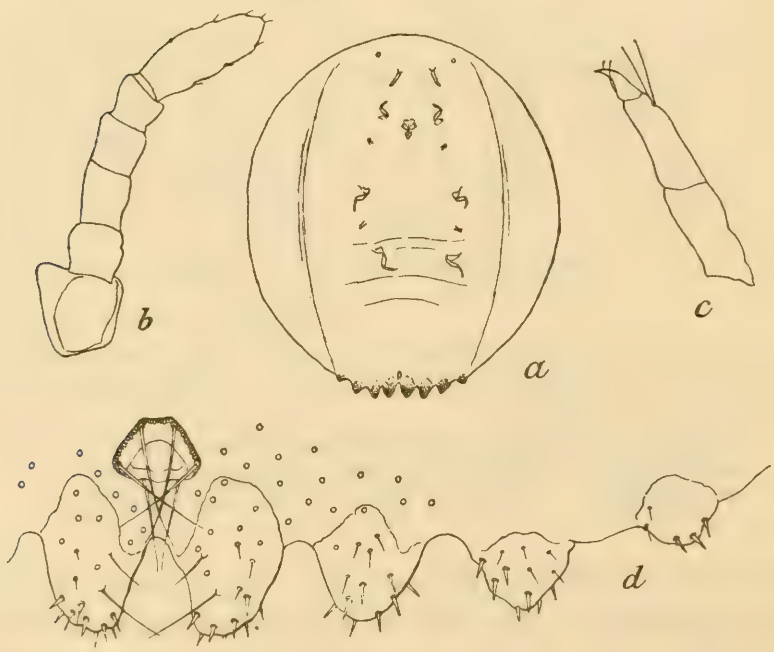

Fig. 3. *Rhizococcus lobulatus*, Green, sp. n.; *a*, adult female (under compression), × 13·5; *b*, antenna, × 210; *c*, part of mid leg, × 210; *d*, posterior extremity of female, × 100.

Rhizococcus lobulatus, sp. nov. (fig. 3).

Adult female dark reddish brown (dried examples); naked; broadly oval or subcircular, moderately convex, the segments well defined. Posterior extremity (fig. 3, *a*, *d*) with eight prominent chitinous lobes, the median (anal) pair largest,

the others decreasing in size to the outermost, which is always small and sometimes obsolescent. Each lobe surmounted by some rather slender, sharply pointed spines; the anal pair with two longish slender setae on the inner side directed obliquely backwards. Derm with numerous small circular pores and some minute spiniform hairs. Anal ring with six slender setae. Antenna (fig. 3, *b*) 6-jointed, the 6th much the longest, 5th shortest, the remainder subequal. Limbs small but robust. Foot (fig. 3, *c*) with a stout falcate claw; tarsus equal in length to tibia. Length of complete insect 2·75 to 3·0 mm. Breadth (under compression) 2·25 to 2·50 mm.

NEW SOUTH WALES: Bramble Station, near Condobolin, on *Acacia pendula* (*W. W. Froggatt* No. 341).

Rhizococcus lecanioides, sp. nov. (fig. 4).

Adult female dark castaneous brown; naked; smooth, with some shallow foveae on the sides. Derm rigid and strongly chitinized, though clearing completely in potash; oval, narrower behind; strongly convex dorsally, concave below where the margins of the body clasp the branch upon which the insect rests (fig. 4, *a*). Antennae and limbs proportionately very small and weak. Antenna (fig. 4, *c*) very indistinctly segmented, apparently 6-jointed, the 3rd longest, the 1st incomplete

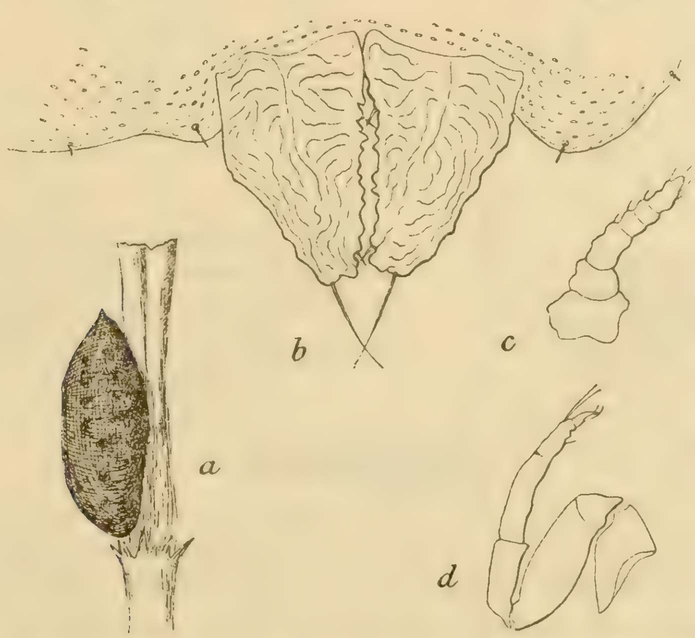

Fig. 4. ***Rhizococcus lecanioides*, Green, sp. n.; *a*, adult female, side view, × 11; *b*, anal lobes, × 210; *c*, antenna, × 210; *d*, anterior leg, × 20.**

and of indefinite form. Tarsus unusually long, at least one-and-a-half times as long as the tibia (fig. 4, *d*), with a deep incision at about one-third of its length from the distal end, which gives the tarsus the appearance of being two-jointed. Anal lobes (fig. 4, *b*) large, stout and prominent, densely chitinous and strongly wrinkled, with two small spines on the inner edge and a comparatively short stout seta at the extremity of each lobe. Derm without spines, but thickly set with small irregularly oval chitinous lenticels which appear to be arranged in roughly concentric series. Anal ring with eight stout setae. Length, 2·0 to 2·50 mm.

VICTORIA: Sandringham, on slender twigs of *Casuarina* (*C. French*, No. 113, *a*).

Asterolecanium stypheliae, Mask., var. **multiporum,** nov. (fig. 5).

Differs from the type in its larger size, and in the greater size and number of both paired and simple marginal pores (vide fig. 5, *a* and *b*). In all other characters it agrees closely with the type. In typical *stypheliae* the simple pores accompanying the paired pores are in a single row—one simple to each paired pore (fig. 5, *b*); in var. *multiporum* the simple pores are two or three deep (fig. 5, *a*). The puparium of typical *stypheliae* has an average length of 1·50 mm., while that of var. *multiporum* measures 2·25 mm.

VICTORIA: Warrnambool, on *Samolus repens,* Nov. 1914 (*C. French,* No. 168).

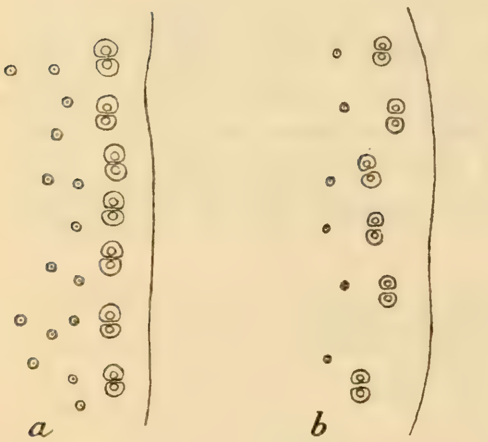

Fig. 5. Marginal pores of: *a, Asterolecanium stypheliae* var. *multiporum,* Green, nov.; *b, A. stypheliae,* Mask., × 375.

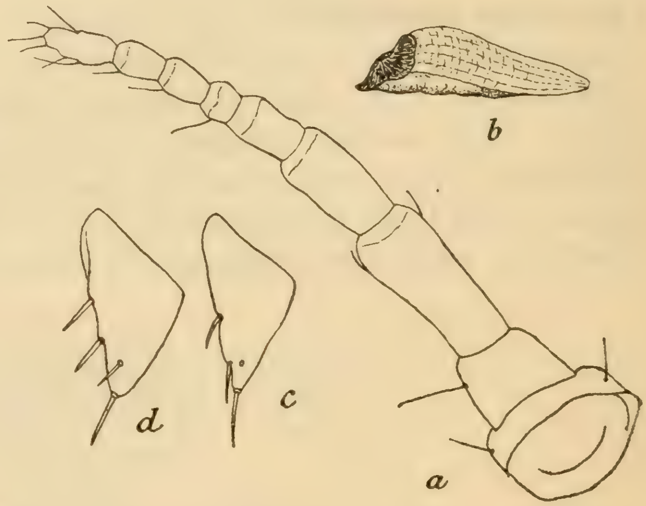

Fig. 6. *Pulvinaria maskelli,* Olliff, var. *novemarticulata,* Green, nov.; *a,* antenna, × 210; *b,* adult female and ovisac, side view, × 4; *c,* valve of anal operculum, × 100. *P. maskelli* var. *spinosior,* Green; *d,* valve of anal operculum, × 100.

Pulvinaria maskelli, Olliff, var. **novemarticulata,** nov. (fig. 6).

Differs from the type, and from var. *spinosior,* in having distinctly 9-jointed antennae (fig. 6, *a*). The additional joint is evidently a subdivision of the 5th, but the separation is as complete as that between any of the other joints. The valves of the anal operculum are strongly spined (fig. 6, *c*), only slightly less so than those of var. *spinosior* (fig. 6, *d*). The ovisac (fig. 6, *b*) is strongly convex and distinctly fluted longitudinally. The body of the insect is tilted upwards and rests on the anterior extremity of the ovisac. Total length of insect and ovisac, 7 mm. Dimensions of adult female (under compression), 4·50 to 5·50 mm. by 3·50 to 4·0 mm.

VICTORIA: Mallee, massed on slender branches of *Hymenanthera dentata* (*C. French* No. 161).

Chionaspis frenchi, sp. nov. (fig. 7).

Female puparium white, pellicles reddish; broadest across the middle, rounded behind, moderately convex. Length, 2·50 to 2·75 mm.

Male puparium white; flattish; very obscurely carinate. Length, 1·50 mm.

Adult female elongate, narrowed in front, broadest across the abdominal area; lateral margins of abdominal segments moderately protuberant. Pygidium (fig. 7) with two prominent, obscurely tricuspid median lobes, and a single small but prominent lateral lobe on each side, about half the breadth of the median lobes. The most conspicuous feature of the pygidium is the series of broad semilunar marginal pores, one between the median and lateral lobes and others, in pairs, at intervals along each side of the pygidium. Each of these marginal pores gives rise to a conspicuous broad flat plate, the free edge of which may be pointed, rounded, or obscurely serrate, and in the interval between the pairs is a complex marginal prominence, which appears to consist of narrow finger-like processes overlying each other. Circumgenital glands in five groups; median group small, 2 to 4 pores only; upper laterals, 12 to 16; lower laterals, 15 to 23. Dorsal oval pores large and conspicuous, in interrupted series. Length, 1·25 to 1·75 mm.

Length of nymphal pellicle, 0·75 mm.

VICTORIA: Mallee, on *Eucalyptus* (*C. French*, Nos. 145 and 167).

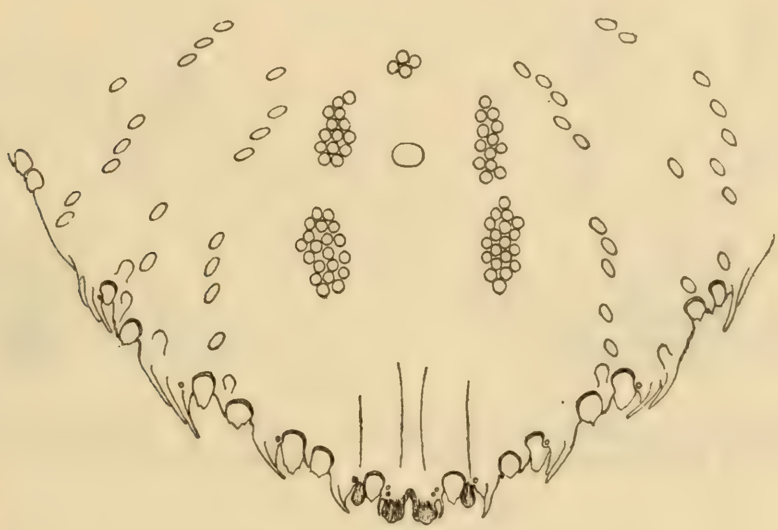

Fig. 7. *Chionaspis frenchi*, Green, sp. n.; pygidium of adult female, × 210.

Chionaspis angusta, Green.

Froggatt has recently described, as *Chionaspis eucalypti*, a species which must be referred to my *Ch. angusta*, described in the *Victoria Naturalist* (xxi, p. 67) in 1904. I must myself accept the responsibility for this mistake, as Mr. Froggatt submitted his specimens to me for determination, and I failed to recognise them at the time. The examples on *Eucalyptus* are distinctly larger, and the puparia more dilated, than are the original specimens from *Leptospermum*; but the structural characters of the insect are typical.

Fresh material received from Mr. French (No. 74) show the typically narrow puparia, which are, in these examples, overlaid by a considerable quantity of loose flocculent white secretionary matter, disguising their true form.

Aspidiotus tasmaniae, sp. nov. (fig. 8).

Female puparium circular or broadly oval, moderately convex; opaque white or ochreous white. Exuviae exposed; subcentral; stramineous to fulvous. Diameter, 1·25 mm.

Male puparium oblong oval; white; larval pellicle nearer one extremity. Length, 1·0 mm.

Pygidium of adult female (fig. 8) with six lobes; the central pair large and prominent, obscurely tricuspid; the two outer pairs small, narrow and sharply pointed. Margin between median and inner lateral lobes rather deeply and broadly excised and thickened. There is a similar but narrower excision immediately behind each outer lateral lobe. Squames long and deeply fimbriate, the series extending beyond the outer lobes. Circumgenital glands in four or five groups, the median—when present—contains from 1 to 3 pores only; upper laterals 10 to 14; lower laterals 5 to 7. Dorsal oval pores conspicuous, extending in linear series inwards from the margin. Body of insect subcircular. Length, 1 mm.

Fig. 8. *Aspidiotus tasmaniae*, Green, sp. n.; pygidium of adult female, × 210.

Fig. 9. *Aspidiotus bidens*, Green, sp. n.; pygidium of adult female, × 210.

Nymphal pellicle broadly oval. Posterior extremity without definite lobes; with three shallow excisions on each side of the termen. Length, 0·65 mm.

TASMANIA: Launceston, on *Ribes* and *Ampelopsis* (*F. M. Littler*)

VICTORIA: On *Eucalyptus*, *Acacia* and *Cytisus* (*C. French*, Nos. 68, 148 and 165).

Aspidiotus (Hemiberlesia) bidens, sp. nov. (fig. 9.)

Female puparium dirty white; irregularly circular, moderately convex. Exuviae yellowish, eccentric. Diameter about 1·65 mm.

Adult female broadly oval, somewhat sharply pointed at posterior extremity. Pygidium (fig. 9) with a single median pair of large and prominent lobes, slightly excised on the outer edge, their bases extending inwards. Marginal spines long. Pectinate squames very delicate and inconspicuous, apparently three on each side, discernible only by careful illumination. No circumgenital glands. Dorsal pores few. Anal aperture comparatively small. Length, 1·50 mm.

VICTORIA: Lake Albacutya, on *Casuarina* (*C. French*, Nos. 115 and 122).

Aspidiotus (Targionia) cedri, sp. nov. (fig. 10).

Female puparium circular, flattish; very dense; very dark blackish brown, inner surface sometimes whitish. Pellicles concealed, the position of the larval pellicle marked by a small raised boss. Diameter, 1·50 to 1·65 mm.

Adult female (fig. 10, *a*) roughly circular. The pygidium—which occupies practically the whole of the abdominal area—broadly rounded, but deeply indented at the junctions of the suppressed segments. Posterior margin (fig. 10, *b*) with four broad, but only slightly prominent, obscurely tricuspid lobes, set close together, with thickened inward extensions. Beyond the lobes, on each side, the margin is strongly cristate, with three large and well-defined prominences which simulate lobes. On each side of the median lobes is a conspicuous translucent curved channel running inwards to the minute anal orifice. There are no circumgenital glands. Length, 1·25 to 1·50 mm.

QUEENSLAND: on cedar logs (*C. French,* No. 111).

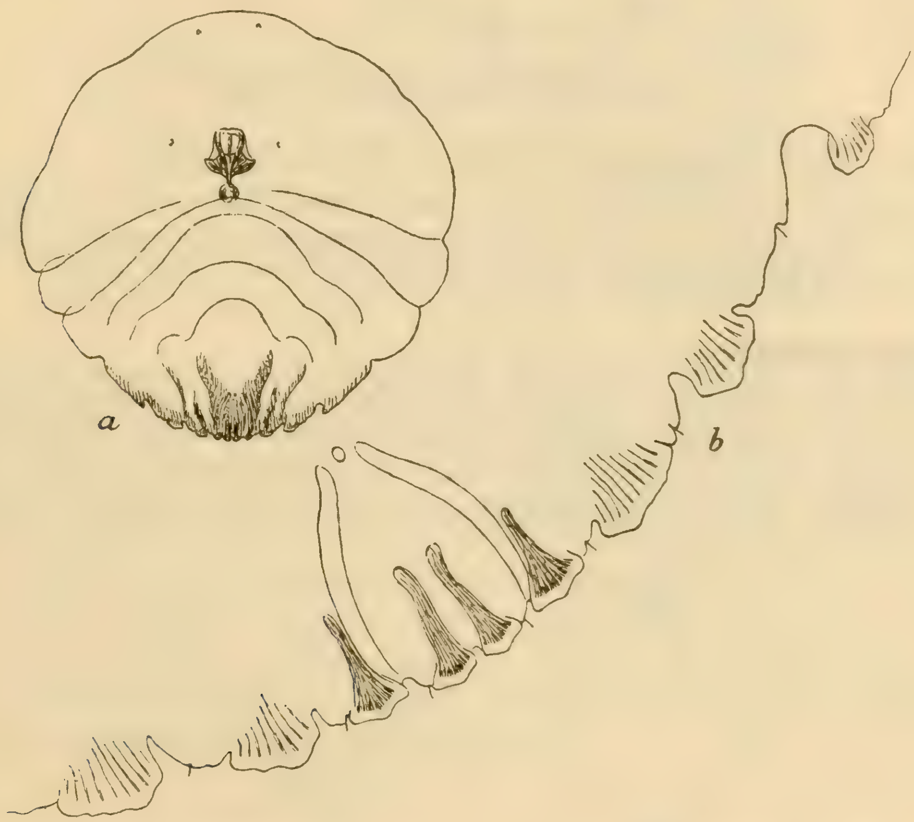

Fig. 10. *Aspidiotus cedri,* Green, sp. n.; *a,* adult female, × 30; *b,* posterior margin, × 210.

Mytilaspis (Fernaldella) beyeriae, sp. nov. (fig. 11).

Female puparium opaque white, pellicles rufous or reddish ochreous; elongate, slightly broader across the middle, moderately convex; smooth. Length, 2·50 mm. Breadth, 1 mm.

Adult female elongate, broadest across the median area, posterior extremity evenly and broadly rounded. The derm of the whole insect is rigid and strongly chitinized, with no differentiation between the pygidium and the other parts of the

body. Posterior margin with four small and rather narrow lobes (fig. 11), the median pair widely separate, the space between them being approximately twice as great as that between the median and lateral lobes. There are no tubular squames. Marginal spines very small. There is a deep marginal pore situated centrally between the median lobes, another between the median and lateral lobes, and others—usually in pairs—at points corresponding with the junctions of the suppressed segments. No circumgenital glands. Dorsal pores numerous, minute. Length, 1·50 to 1·75 mm.

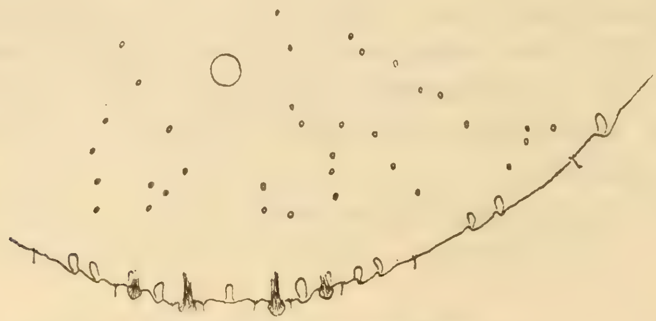

Fig. 11. *Mytilaspis beyeriae*, Green, sp. n.; pygidium of adult female, × 210.

VICTORIA: Mallee, on *Beyeria viscosa* (*C. French*, No. 100).

The unusually wide interval between the median lobes, and the rigid derm of the body of the insect, are characters that distinguish this species from any other known members of the genus.

Protodiaspis anomala, sp. nov. (fig. 12, 13).

Female insects forming no definite puparium, but lying beneath a mass of loose white filamentous secretion, amongst which the larval pellicles remain entangled.

Adult female considerably smaller than, and completely enclosed within the nymphal pellicle. Body of adult female (fig. 12, *a*) more or less globose; the pygidium

Fig. 12. *Protodiaspis anomala*, Green, sp. n.; *a*, adult female, × 41; *b*, pygidium of adult female, × 210.

(fig. 12, *b*) flattened, cordate acuminate. There are no definite lobes, but there are one or two small irregular and asymmetrical marginal prominences on each side near the termen. Anal orifice small, situated quite at the base of the pygidium. No circumgenital glands. A few very small spines on the disk, and one marginal spine on each side, near the base. Many linear thickenings of the derm run inwards from the margin. Length, 0·50 to 0·75 mm.

Nymphal pellicle (fig. 13, *a*) globose and irregularly tumescent; densely chitinous, ochreous brown. The posterior extremity (fig. 13, *b*) bears a hinged semicircular plate covering a large aperture through which the larvae make their escape. The marginal area of this plate is marked with a polygonal cellular pattern. Length, 0·65 to 1·0 mm.

Male puparium elongate, narrow, compact, flat; white; uncarinated; the larval pellicle ochreous, dehiscing circumferentially (as in the genus *Aspidiotus*), the two members being conspicuous at the anterior extremity, on the dorsal and ventral surfaces of the puparium respectively. Length, 1·15 mm.

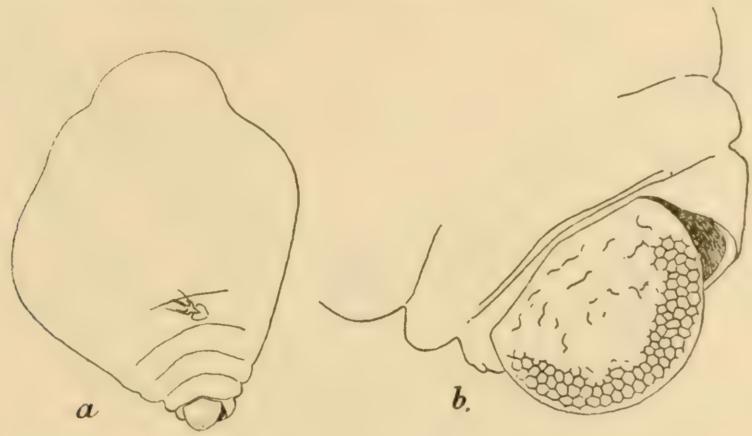

Fig. 13. ***Protodiaspis anomala*, Green, sp. n.; *a*, nymphal pellicle, × 41; *b*, posterior extremity of pellicle, × 210.**

VICTORIA: S. Morang, Dixon, on bark of *Acacia* sp. (*C. French*, No. 109).

Cockerell erected the genus *Protodiaspis* to contain Diaspine species "secreting no distinct scale, but the females enveloped in cottony secretion, the male pupae resembling those of *Diaspis*. No grouped circumgenital glands"—to all of which characters the present species conforms. It is also clearly congeneric with *Fiorinia syncarpiae* of Maskell—a species that Cockerell proposes to refer to *Protodiaspis*. My *Fiorinia secreta* ("Cocc. Ceylon," I, Pl. xxxiii), which constructs no scale, but inhabits a gall, bears many resemblances to *P. anomala*. *Protodiaspis agrifoliae* of Essig is scarcely referable to this genus. The insect has a distinct—though very small—scale, and possesses circumgenital glands.

ON A WIDELY DISTRIBUTED GAMASID MITE (*LEIOGNATHUS MORSITANS*, SP. N.), PARASITIC ON THE DOMESTIC FOWL.

By Stanley Hirst.

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The species of *Leiognathus* described below apparently has a very wide distribution in Africa and is also found in Mauritius, China, India and South America. It seems indeed to be the common blood-sucking Gamasid mite of poultry in these countries. As it is highly probable that this parasite transmits spirochaetosis, and perhaps other

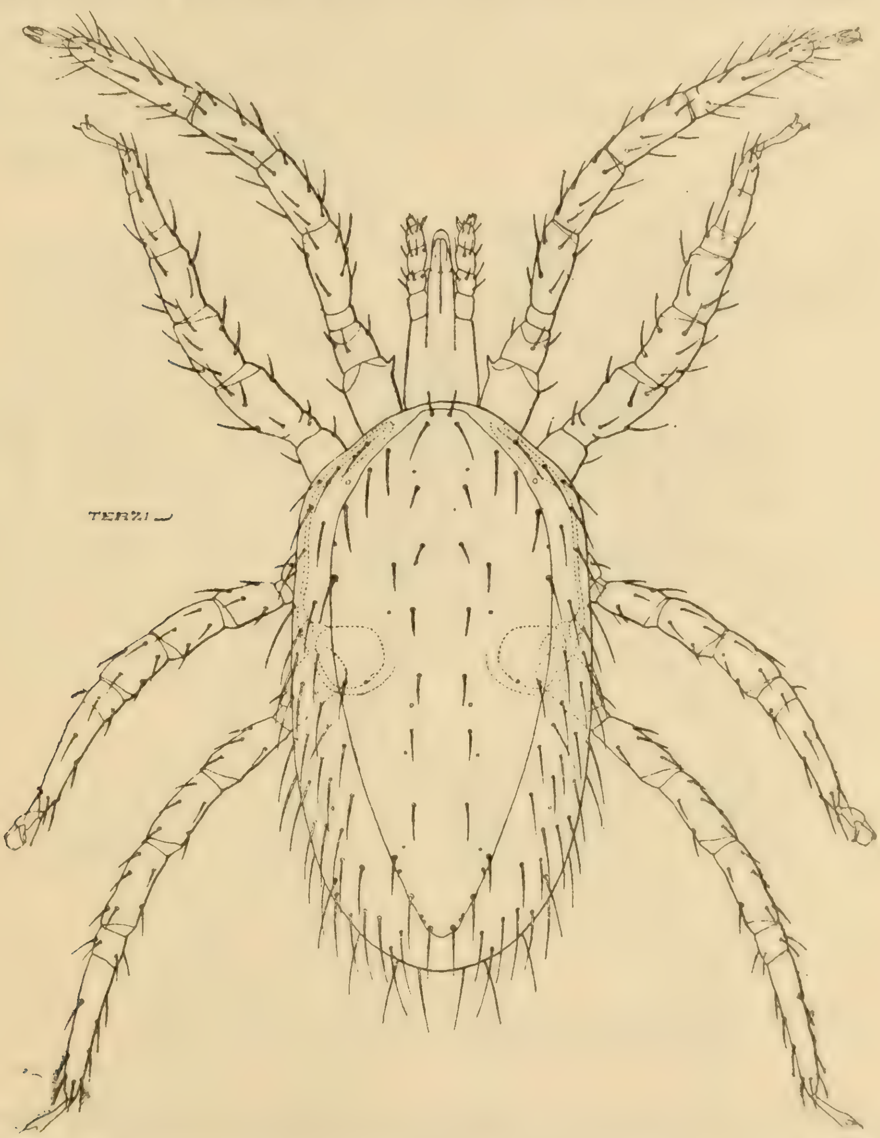

Fig. 1. *Leiognathus morsitans*, Hirst ; dorsal view of female.

diseases of the fowl, it is desirable that further information about its distribution and life-history should be obtained. Two instances of this mite attacking man are recorded below in the list of localities.

Prof. Antonio Berlese has described a species of fowl mite from Buenos Aires under the name *Leiognathus bursa* which may be the same as the one dealt with in this note ; his description is very short, however, and leaves me in much doubt on this point.

Leiognathus morsitans, sp. n.

? *Leiognathus bursa*, Berlese, Bull. Soc. ent. Ital., xx, p. 208, pl. ix, fig. 6 (1888).

♀. *Body* long, oval and narrowed anteriorly. *Dorsal shield* (fig. 1) long and rather narrow, leaving a marginal strip of the soft integument of the body unprotected; it is widest at some distance from the anterior end, but is progressively narrowed posteriorly and pointed at the end. Surface of shield almost smooth, but it is slightly roughened by a faint reticulate sculpturing. Two pairs of hairs are placed close together in the middle of the front end of it, the posterior pair being long. Besides these two anterior pairs, there are seven *inner pairs of hairs* on the shield, all of them being *short* and fine; they practically form a longitudinal series, the

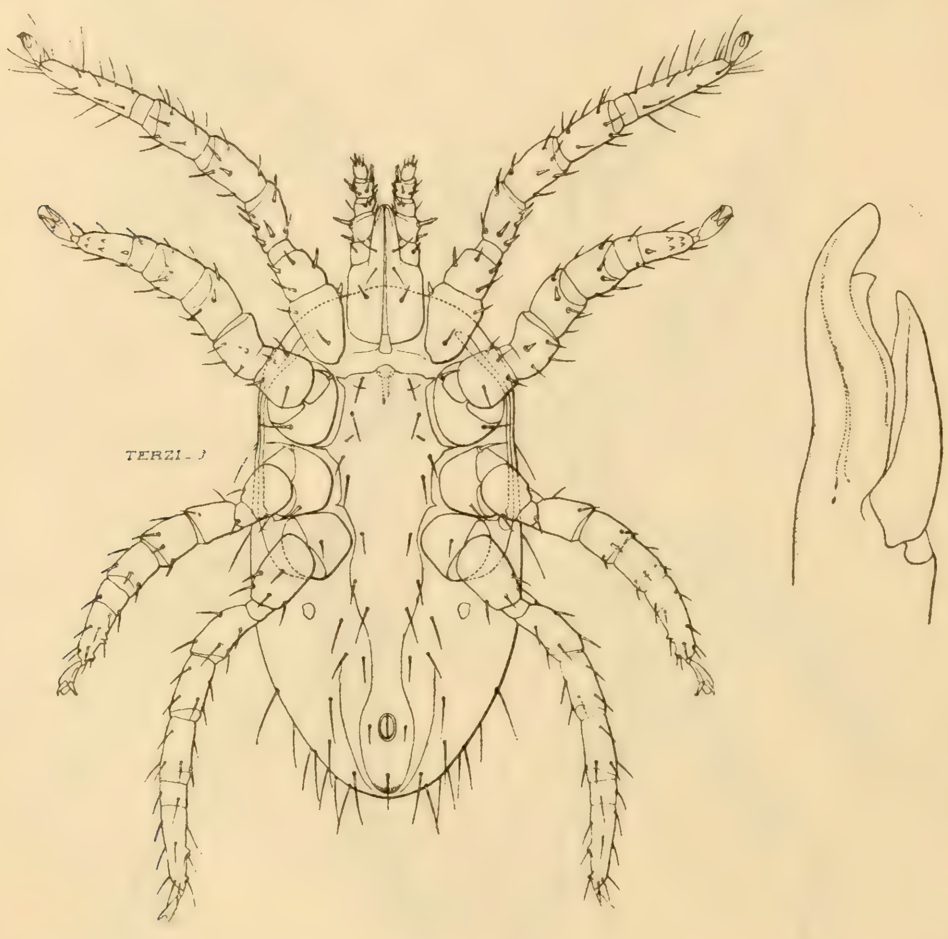

Fig. 2. *Leiognathus morsitans*, Hirst; ventral view and chelicera of male.

hairs of the third pair being placed, however, further apart than the others. Nearly all the *marginal hairs* of the shield are long, especially the anterior ones; two pairs of long hairs are also present at the posterior end and another pair of shorter hairs is situated just in front of them. There are numerous long hairs on the uncovered part of the dorsal surface.

Sternal plate practically trapezoidal in shape and furnished with three pairs of fairly long hairs. *Genito-ventral plate* and *anal plate* normal in appearance. *Peritreme* long, reaching about as far forwards as the middle of the coxa of the first leg. Anterior surface of coxa of second leg furnished with a slender spine, as in *L. bacoti*. There is

also a short but distinct spinule (or spur) at the distal end (on the inner side) of the coxa of the first leg. First leg longer than the fourth; second and third legs rather short, the former being stout. Fingers of *chelicera* moderately long and unarmed.

Colour (in spirit) usually yellowish, but sometimes red.

Length of body, ·65–·7 mm.

♂. *Dorsal shield* not unlike that of the female, but broader; the arrangement of the hairs on its surface is practically the same in both sexes. *Peritreme* long. *Ventral plate* provided with seven or eight pairs of hairs and also with the usual unpaired posterior hair. Tarsi of legs 2–4, furnished below with slight distal spurs, which are separated from one another by a distinct interval. Some of the hairs on the lower surface of the legs are short and spiniform (see fig. 2). Second free segment of *palp* with two especially noticeable lateral spines. *Chelicera* as figured (see fig. 2). *Length of body*, ·5 mm.

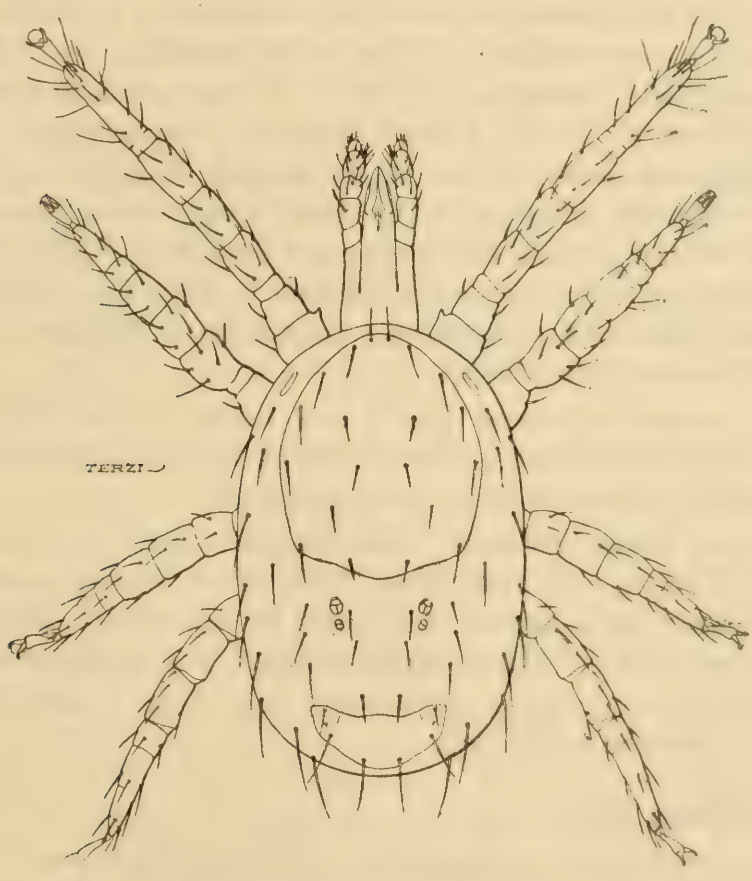

Fig. 3. *Leiognathus morsitans*, Hirst; dorsal view of protonymph.

Protonymph.—Shape of dorsal shields as shown in figure 3. Hairs on *anterior dorsal shield* twenty in number; the second pair and those on the lateral margins being long, but the central hairs short. *Posterior dorsal shield* shaped very like that of *L. bacoti*, Hirst, and the three pairs of hairs on it are also very similar, those of the anterior pair being short, but the others long. Two pairs of distinct little platelets are present between the two shields. Hairs on uncovered part of dorsal

surface long. *Peritreme* short, slender and curved. *Sternal plate* reaching backwards as far as the interval between the third and fourth legs (or slightly further) and provided with three pairs of hairs. *Length of body*, ·34 mm.

Localities.—Bathurst, Gambia: on fowls, 25.ii.1911 (Dr. J. J. Simpson). Abinsi, R. Benué, N. Nigeria: on chickens suffering from spirochaetosis, 19.ix.1912 (J. M. Dalziel); specimens kindly lent me for examination by the Rev. James Waterston. Yaba, S. Nigeria: a single example from a lizard (Dr. J. W. Scott Macfie). Zanzibar: a number of specimens taken on human beings (Dr. W. M. Aders). Port Herald, Nyasaland: a very large number of specimens found on nesting hens (Dr. J. E. S. Old). Mfongosi, Zululand: a number of specimens from domestic fowls, collected by Mr. W. E. Jones and kindly forwarded to me by Mr. E. C. Chubb, Curator of the Durban Museum. Mayotte, Comoro Islands: specimens from a bird called by the natives "Hibou," collected by G. F. Leigh, 12.v.1911, and presented to the Museum by the Hon. N. Charles Rothschild. Curepipe, Mauritius: very numerous examples from the domestic fowl and common sparrow (*Passer domesticus*), also others from the sparrow of Brazil and Cardinalis, Dec. 1911 (collected by C. Baichoo and presented to the British Museum by the Hon. N. Charles Rothschild). Central Fukien, China: May 1913, in fowl-house (collected by Dr. J. P. Maxwell and kindly lent me for examination by Prof. G. H. F. Nuttall, F.R.S.). Ahmednagar, Deccan, India: 1913, a single specimen found by Dr. H. L. Howell, R.A.M.C., on a lady patient suffering from "very bad irritation of the skin" alleged to be caused by the mite; "it raised small red lumps with white tops and looked as if the insects burrowed; irritation was intense even for days after the bite." Bahamas: on fowls, 19.iii.1908 (Mr. J. K. Brace). Mariquita, Columbia: on chickens, May and December, 1914, (Dr. Andrew Balfour and Mr. Pinto).

Much of the material recorded above was received from Mr. Guy Marshall, Director of the Imperial Bureau of Entomology; my best thanks are due to him for kindly permitting me to examine these specimens.

In an interesting paper, entitled "The English Sparrow as an Agent in the Dissemination of Chicken and Bird Mites,"* Mr. H. E. Ewing records the presence of two parasitic mites (*Dermanyssus avium* and *D. gallinae*) on the English sparrow in the United States. His "*Dermanyssus avium*" is a *Leiognathus*, but probably it is not *L. morsitans*, for Ewing's experiments seem to show that his species cannot establish itself on the domestic fowl.

Dermanyssus gallinae, Redi.

It would be interesting to ascertain the exact distribution of this bird mite in the warmer regions of the world. It is probable that *D. gallinae* and *Leiognathus morsitans* have been confused with one another in reports dealing with parasites of poultry in tropical regions. Unfortunately, all the specimens of *D. gallinae* in the British Museum collection are from European localities, and so I am unable to discuss the further distribution of the species.

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* *The Auk*, xxviii (N. Ser.), pp. 335–340, 2 text-figs., 1911.

A PRELIMINARY REPORT ON THE PROBLEM OF CONTROLLING GLOSSINA IN NYASALAND.

By W. A. Lamborn, M.B.,

Imperial Bureau of Entomology.

On initiating this investigation my first aim was to discover a small isolated fly area, such as those described as "primary fly centres" by Dr. Shircore (Bull. Ent. Res., v., pt. 1, p. 87), with a view to carrying out experiments in the clearing of bush and endeavouring to reduce the numbers of the fly by systematic capture on a large scale.

With these objects in view I decided that I could not do better than proceed to the sleeping sickness area discussed in the paper referred to; but owing to much delay in the course of my voyage out, I did not arrive until almost the end of the dry season, so that it was only possible for me to examine two of the "primary fly centres" before the rains, though the remaining two were examined subsequently.

On examination of the Nyansato district (see Dr. Shircore's map facing p. 90), in late October and early November, before any rain had fallen at all, the fly was found over a very large area, which commenced about 2 miles from Domira Bay and extended nearly to Matumba's villages, a distance of about 8 miles in a direct line from east to west. Detours were then made so as to enter the district directly both from the south and from the north, the result being that in a direct line from south to north the fly was found over an area of 10 miles, extending right up to the edge of the clearing made round Mtalamanga's chain of villages. The observations made in this locality were confirmed subsequently in the course of frequent visits for the purpose of studying the fly.

The Lingadzi district was then examined, also before the rains. The fly was found sparingly a mile to the north of Mtalamanga's, at no great distance from the edge of the clearing, and a little further to the north it was obtained in numbers over a distance of approximately 10 miles in a direct line as far as the Chitua River, far beyond the Lingadzi. From east to west fly extended in this region from a point 2 miles west of the dambo at Makko, along the course of the Lingadzi for 10 miles in a westerly direction.

The examination of the Kuti marsh district and of the Patsanjoka marsh district was only completed after the onset of the rains. The fly distribution in these areas was then found to be continuous, extending from east to west for 15 miles, and from the Lintipi River in the south right up to Nyansato in the north, approximately 15 miles in a direct line.

To summarise my observations:—No evidence of the natural splitting of the northern portion of the fly area in the dry season into two *small* localised patches was found, though two large areas do certainly exist as a result of the subdivision of one larger one by native clearings; and in the southern portion, examined after a few scanty rains, the two so-called "primary centres" were certainly continuous with each other and with the northern portion of the area, the fly extending over so large a region as to make one sceptical in regard to the possibility of their limitation to within narrow patches so short a time before.

Fly is undoubtedly more concentrated in this district in the dry season than in the wet, coincident with the greater concentration of the game which then takes place, as I have been informed by several professional hunters and others, the reason for which is not far to seek. Over the greater part of the country in the dry season rivers and water-holes dry up, all shady verdure disappears, and the grass is burnt off, leaving a blackened wilderness which then compels the game to seek certain localities, such as are included in the area under consideration, where they can obtain shade and the necessities of life. This district, partly woodland and partly plain and all lowlying ground, is situated between Lake Nyasa to the east and tiers upon tiers of mountains to the west, and is in the wet season, as I am informed, permeated by numerous rivers and streams, when large areas often remain under water for weeks. Its soil is composed of rich black humus and, unlike that in other parts, contains little sand, which with the constant presence of subsoil water renders it extraordinarily fertile. Even in the dry season over the greater part of the area water is only surface deep and is always obtainable in the extensive marshes and elsewhere in hollows ; as a consequence grass is to be found here when no vestige can be seen elsewhere, and large forest trees, such as are found nowhere else at the same elevation, occur abundantly and always afford a certain amount of shade. In this district in the late dry season the grass was ankle-high when not a single blade could be seen in other parts, and as further evidence of the fertility of the soil it may be added that the native farmer can grow as many as two or three crops of maize on it in a favourable season, when elsewhere only one can be raised, though comparatively very little is under cultivation. Certain districts are well populated, but the habitations are all arranged along three definite narrow lines, so that the greater part is rarely traversed by human beings. The reasons for the concentration of the game are therefore obvious, and it seems a natural corollary that the fly, which, so far as has been ascertained at present, is entirely dependent on the game, should concentrate at the same time.

Though the fly does occupy certain definite regions in the dry season from which, as I quite agree, they radiate out farther afield when the grass springs up everywhere and the game spreads abroad, the foci, in this district at all events, are in my opinion far too extensive to make any experimental attempt at clearing and reducing their number by systematic capture practicable. I have not been able to discover that the " primary centres " form localised breeding grounds, so that this very attractive hypothesis is up to the present unsupported by a shred of evidence.

The whole question will be more fully studied in another district at a later date.

Flight Experiments with Glossina morsitans.

Preliminary experiments have been conducted with a view to determining the range of flight of *Glossina morsitans*.

Between 4th and 22nd December, 1,810 males and 312 females were captured in the Lingadzi district, where the elevation is about 1,700 feet, and between 4th and 17th December 854 males and 66 females had been marked and released at two different points—at Chunzi, at an elevation of 2,420 feet, 10 miles due south of the Lingadzi fly area ; and at a spot which has an elevation of 1,950 feet and is situated 2 miles south of the Lipimbi River and 5 miles south of the same fly area.

The flies released at Chunzi were marked by snipping off the first right foot through the middle of the metatarsus, an injury unlikely to occur in nature, and those released at the second spot were marked by snipping through the second foot on the same side. Their fitness seemed to be little impaired by the operation, for test specimens fed on a goat with avidity a few minutes after it, and it is usual to be much assailed by such flies immediately they are released.

By 7th December, 270 males and 29 females had been released at Chunzi, and on this date on proceeding in the direction of Lingadzi I recaptured one, a male, half a mile away. Two days later 379 males and 57 females had been released at the same place, and two males were then recaptured 2 miles to the south in the direction of the same fly area.

TABLE I.

Showing Numbers of Tsetses released and recaptured later.

Releases.					Recaptures.			
Date.	Locality.	♂	♀	Total.	Place of recapture.	♂	♀	Where released.
4 Dec.	Chunzi	73	11	84				
5 ,,	,,	76	6	82				
7 ,,	,,	121	12	133	½ mile S. of Chunzi	1		Chunzi.
8 ,,	,,	47	13	60				
9 ,,	,,	62	15	77	2 miles S. of Chunzi.	2		Chunzi.
10 ,,	Lipimbi	38	9	47				
11 ,,	,,	97	—	97				
12 ,,	,,	126	—	126	Lingadzi ..	2		One at Chunzi, the other near Lipimbi R.
14 ,,	,,	76	—	76	Lingadzi ..	1		Near Lipimbi R.
15 ,,	,,	138	—	138	Lingadzi ..	3		,, ,,
16 ,,	,,	—	—	—	Lingadzi ..	2		,, ,,
17 ,,	,,	—	—	—	Lingadzi ..	1		,, ,,
22 ,,	,,	—	—	—	Lingadzi ..	2		,, ,,
	Totals	854	66	920		14		

On 10th December I commenced to release flies at the second spot south of the Lipimbi, where by 12th December 261 male and 9 female flies had been set free. On this date one of the males was retaken at Lingadzi at the same time with another male which had been set free at Chunzi on a date between the 4th and 9th. By the 14th, 337 males and 9 females had been released at this place, and another male originally released here was on this date taken at Lingadzi. On 15th December, 138 additional males were released and 3 more were retaken at Lingadzi, where also on the 16th 2 more males, on the 17th 1 more male, and on the 22nd 2 more males, were recaptured. Evidence has therefore been obtained of ten flights of 5 miles and of one flight of no less than 10 miles back to the locality from which the flies were

originally taken, and in the case of three other flies, of flights tending to show that they were on their way back also. The flies recaptured were all taken at the fringe of the fly area, where, on account of the greater probability of meeting with them, the collectors had instructions to work. The country which they necessarily traversed is all well-wooded and without open spaces, and though careful search was made for released flies in directions away from the main fly area, none were obtained. No flies were fed previous to release. The results are appended in tabular form (Table I). I propose to continue experiments on these lines, using also flies which have been well fed before release.

The Proportion of the Sexes.

Record has been kept of the numbers of tsetse-flies captured and the proportion of the sexes, the results of which are appended (Table II). The number of fly boys engaged in the work of collecting has not been constant, neither has the work been uniform, so that no just deductions can be drawn from the figures as to the numerical prevalence of the flies.

TABLE II.

Showing captures of G. morsitans.

Locality.	Date.	Males.	Females.	Total.
Matumbas	20th Nov. ..	15	8	23
,, ...	21st ,, ..	51	24	75
,, ...	24th ,, ..	38	6	44
,, ...	25th ,, ..	51	31	82
,, ...	26th ,, ..	43	18	61
,, ...	28th ,, ..	42	24	66
,, ...	30th ,, ..	94	19	113
,, ...	1st Dec. ..	12	5	17
Lingadzi	5th ,, ..	119	23	142
,, ...	7th ,, ..	104	14	118
,, ...	8th ,, ..	114	38	152
,, ...	9th ,, ..	117	24	141
,, ...	10th ,, ..	130	40	170
,, ...	11th ,, ..	167	18	185
,, ...	12th ,, ..	133	14	147
,, ...	14th ,, ..	115	10	125
,, ...	15th ,, ..	175	12	187
,, ...	16th ,, ..	84	15	99
,, ...	17th ,, ..	159	27	186
,, ...	21st ,, ..	93	33	126
,, ...	22nd ,, ..	184	27	211
Totals		2,040	420	2,460

Trapping Experiments.

In accordance with Sir Patrick Manson's suggestion, a cage of wire mosquito-proof netting was constructed in a part of the Lingadzi district where tsetses are especially numerous, and in this a goat was incarcerated, the outer side of the cage and the undersides of branches of trees near by being smeared with bird-lime in the hope

of catching the flies attracted by the animal. The results were by no means satisfactory, for no more than eight flies were taken, though the goat remained there for 7 days, a failure possibly to be explained by its not being called upon to move about with any degree of activity, and by the inability of the fly to see such movements as occurred, my experience in this connexion confirming that of other observers, namely, that the flies are attracted especially by moving objects.

Why, however, the odour of the goat, which was especially strong, the animal being a male, should have failed to attract them it is difficult to understand, seeing that, like some TABANIDAE, *G. morsitans* will after a little time discover a freshly killed animal and settle to feed, in which case the fly can only have been drawn to the scene by the sense of smell. When this particular goat was removed and paraded up and down in the vicinity it was much assailed by the flies.

A series of experiments was made in the use of English bird-lime spread on various materials carried on the backs of natives, in the hopes of catching *morsitans* in the same way as *palpalis* is caught in the Island of Principe. The results are tabulated below :—

Date.	Material used.	Boys.	Duration of experiment.	Tsetses captured.
8 Dec.	Deal board, 3 ft. by 3 ft...	a	6 hours	18
9 ,,	Green cardboard, 3 ft. by 3 ft.	a	,,	23
,, ,,	,, ,, ,, ,, ...	b	,,	15
,, ,,	Tarred waterproof paper, 3 ft. by 3 ft. ..	c	,,	39
10 ,,	,, ,, ,, ,, ,, ..	a	,,	17
11 ,,	,, ,, ,, ,, ,, ..	a	,,	29
12 ,,	Board made of dried bamboos laced	a	,,	12
	together, 3 ft. by 3 ft.	b	,,	7
15 ,,	Light brown paper, 3 ft. by 3 ft. ..	a	,,	53
		b	,,	59
16 ,,	,, ,, ,, ,, ,, ...	a	,,	58
		b	,,	67
17 ,,	,, ,, ,, ,, ,, ...	a	,,	31
		b	,,	54
18 ,,	,, ,, ,, ,, ,, ...	a	,,	51
		b	,,	47

As *morsitans* is so frequently observed to settle on the underside of loads carried on the heads of natives, experiments were also made in the use of material limed on the underside carried in a horizontal position, but the results were not so satisfactory as when the material was carried in a vertical position.

Natural Enemies.

Considerable attention has been devoted to the fossorial wasps of the genus *Bembex* as being possibly natural enemies of *morsitans*, one species in particular being especially numerous in the fly area. A long series of specimens, each taken on the wing carrying its prey, shows that this species attacks in particular flies of the families ASILIDAE and BOMBYLIIDAE. Several other species taking various MUSCIDAE and Orthoptera have also been secured.

In mid-December, however, a *Bembex* was actually seen to seize a tsetse-fly and to carry it away. The particular species had been repeatedly observed buzzing round as I walked, but little attention was paid to it at first, seeing that an inquisitive disposition seems to characterise many Sphegid wasps. Then one of the insects was seen to make a rush at a tsetse-fly on my leg, which it failed to secure. When a goat was led through the district three more were seen in the course of half an hour, after flying round and round the animal and hovering a few feet away, to rush at tsetses on it, two unsuccessfully, but the third was captured on the wing having seized one of the flies. So far, all attempts to find out the other habits of the insect have failed, though the matter is receiving attention.

Flies of the family BOMBYLIIDAE, some small species of which exist in great numbers in the Lingadzi district, have also been under consideration as potential enemies of the fly, in view of Mr. Lloyd's discovery of one as a parasite of a tsetse pupa, but little advance has been made, beyond the discovery that three of the species, after careful selection of a site, oviposit in irregular fissures in the ground frequently under trees, though what influence induces them to do so has not been determined.

Tsetses and Caterpillars.

An endeavour was made to ascertain whether the fly will ever feed on Invertebrates by caging them with the caterpillars of a large Saturniid moth, such as were to be found recently in enormous numbers in the Rifu district, where large trees had been entirely defoliated by them. The results were negative.

Spread of the Fly in Marimba District.

When on my arrival in late October I had an interview with H.E. The Governor, he informed me that disquieting reports had been received from members of the Livingstonia Mission to the effect that tsetse-fly had recently spread in from North-Eastern Rhodesia and was within measurable distance of one of their principal stations at Kasungu in the Marimba district, and he asked me if I could make it convenient to look into the matter. I was unable to do so until late December, when I travelled to the district and found *Glossina morsitans* existing over a wide area in small numbers and more abundantly as one approached the border.

The district is hilly and covered with stunted trees, which nowhere approach the size of so many found in the sleeping sickness fly area, and the soil differs in being mostly very sandy, producing small fine grass, growing in many places in tufts only, instead of spreading uniformly. It is very arid also, stretches of 18 miles without a trace of water being several times met with, and as a consequence the district is very thinly populated.

This new fly area is situated in the Marimba district of Nyasaland just north of the Duangwa River, where it crosses into Rhodesia.

I am informed by Dr. J. B. Davey, one of the Medical Officers, that he has also found the fly extending well into Nyasaland south of the Duangwa River, also over a wide area.

General Observations.

As has already been remarked, tsetses are especially attracted by moving objects, and it has been my frequent experience that the faster one moves the more one is

beset, for which reason I now invariably walk rather than cycle in a fly area. If one stands still, such flies as may have been hovering around come to rest on objects near by, frequently on a blade of grass, or they settle on the ground, resuming their attentions immediately one is in motion again; though if one remains still long enough, as I have often found during a rest for lunch in the open; the majority gradually fly away. It is frequent, especially in the early evening, for flies to dog one's footsteps, often for several miles, settling at intervals on the ground behind and again and again catching up, an occurrence I have noticed repeatedly in respect of men walking ahead of me and which I have then been able to verify in my own case.

The interpretation of these facts, and that several flies will often travel on a person for considerable distances without attempting to bite, is not yet clear, but an examination of 43 individuals taken off the ground on various occasions as they followed showed that all were males, and it seems a reasonable supposition that such flies may be lurking in anticipation of the advent of a female. No courtship takes place, several males often making a simultaneous rush at the female on sight, and one seizing her, pairing takes place in the air, the couple then settling. It is by no means uncommon to take off natives in one's company a couple which have been seen to pair, and several times paired couples have been taken by means of bird-lime smeared on material borne on a native's back.

With regard to the distance a fly will travel in pursuit of human beings, it has been a frequent experience when crossing the open plain between the edge of the bush and the lake to find fly with one all the way, a distance of $2\frac{1}{2}$ miles, and in passing up in the dry season from Matumba's villages to Chunzi, a distance of 5 miles, the path being rather devious, one was invariably accompanied by flies all the way.

The distribution and numbers in a given locality undoubtedly vary from day to day, few being sometimes found where previous experiences have led one to expect many, and *vice versa*.

It has been a matter of surprise to find that *G. morsitans* heeds so little the heat of the day, seeing that in my experience other species on the West Coast, *palpalis* in particular, never expose themselves to the rays of the overhead sun, unless compelled to do so.

THE STEGOMYIA SURVEY IN HONG KONG.

In view of the possible danger of the introduction of yellow fever into the Far East the Government of Hong Kong has instituted a very thorough investigation of the mosquitos occurring in the Colony, and the Governor has recently forwarded to the Colonial Office an interim report by Dr. Harold Macfarlane, the Government Bacteriologist, to whom the work has been entrusted.

Dr. Macfarlane states that up to the beginning of this year 14,909 samples of larvae had been collected, and from these 41,000 adult mosquitos had been bred out and pinned. Over 21,000 specimens were forwarded to the Imperial Bureau of Entomology, all of which were identified by Mr. F. W. Edwards, of the British Museum, and Dr. Macfarlane has himself named a further 5,000 from named specimens returned to him by the Bureau.

The following is a list of the species so far found in Hong Kong :—

Anopheles indiensis, Theo.
,, *jeyporiensis*, Theo.
,, *karwari*, James.
* ,, *maculatus*, Theo.
* , *minimus*, Theo.
,, *rossi*, Theo. var. *indefinatus*, Ludl.
* ,, *sinensis*, Wied.
,, *tessellatus*, Theo.
Stegomyia fasciata, F.
* ,, *scutellaris*, Wlk.
,, *w-alba*, Theo.
**Armigeres obturbans*, Walk.
Ochelorotatus macfarlanei, Edw.
,, *togoi*, Theo.
Culiciomyia pallidothorax, Theo.
Culex bitaeniorhynchus, Giles.
* ,, *concolor*, R.D.
* ,, *fatigans*, Wied.
,, *fuscocephalus*, Theo.
,, *mimeticus*, Noë.
,, *sinensis*, Wied.
,, *sitiens*, Theo.
* ,, *tritaeniorhynchus*, Giles.
,, *virgatipes*, Edw.
,, *vishnui*, Theo.
Ficalbia minima, Theo.
Lophoceratomyia minutissima, Theo.
,, *rubithoracis*, Leic.
Mansonioides uniformis, Theo.
Micraedes malayi, Leic.
Uranotaenia macfarlanei, Edw.

In 1902 Dr. J. C. Thomson made a report upon the mosquitos of Hong Kong and noted the occurrence of eight species, which are indicated by an asterisk in the foregoing list. The remaining species had not been previously recorded from the Colony and include three species new to science.

Of the three species of *Stegomyia* which occur in the locality, *S. w-alba* appears to be rare, as it has been found only twice, being bred from larvae taken from a hill-side. *S. scutellaris* is probably the commonest mosquito in Hong Kong. During the summer it is found in practically every Chinese house, breeding in small collections of water in old pots, tins, etc., and it is also found away from houses. It does not appear to matter whether the water in which it breeds is clean or dirty. The search for *S. fasciata* has given considerable trouble, but the most recent results show that it not only exists, but is also much more prevalent than might be thought.

In Kowloon 96 separate finds of *S. fasciata* larvae were made between the 15th April and 29th September, 1914; but the European half of Kowloon Point had not yet been examined. Of the 64 finds of these larvae made by Dr. Macfarlane himself, between the 19th August and 23rd September, no less than 53 (84 per cent.) were obtained in stored clean water used for drinking, cooking, etc. In every case the larvae were found

in areas which are densely built over, either in the houses themselves or in their immediate vicinity. It is noted as an important point that it was unusual to find this *Stegomyia* breeding in miscellaneous receptacles, such as old jars, tins, etc., as recorded by observers elsewhere, even though these breeding places were subjected to specially careful and prolonged search both by Dr. Thomson and Dr. Macfarlane. Such receptacles were nearly always occupied by the larvae of *S. scutellaris*, while *S. fasciata* showed a very marked preference for the clean water stored for household purposes. With the exception of a few licensed premises, none of the Chinese houses in Kowloon have water laid on, and all water for drinking, cooking, etc., has to be carried from stand-pipes in the street and stored in the kitchen or yard in barrels, jars, or pails. As the labour of carrying this water is considerable, the storage receptacle is not frequently emptied or cleansed. The water is also used more economically, the average amount per head being about half that used in Victoria. The larvae have therefore plenty of time to develop, and owing to their well known habit of going to the bottom when the water is disturbed, they are not likely to be taken out when water is removed for cooking or other purposes. Experience showed that if the receptacle was full, the chance of capturing larvae was very small; it may therefore be assumed that many well-filled barrels, etc., were passed as free from mosquitos owing to the impossibility of catching the larvae. The observations of Messrs. Howard, Dyar and Knab in America are quoted to show how closely the larvae can cling to the bottom of a vessel, for even if a barrel be turned upon its side, it will be found that about 80 per cent. of the larvae will stay in the few remaining ounces of water.

Dr. Macfarlane considers that the results so far obtained in Kowloon would appear to indicate that if the storage of clean water could be completely done away with by laying on a continuous tap supply in the houses, the chief breeding places of *S. fasciata* would be destroyed; provided that no cisterns are allowed unless they are completely protected.

The miscellaneous jars in houses and backyards in Victoria have been very thoroughly examined, with the result that only in three cases have *Stegomyia fasciata* larvae been taken, and these in widely separated localities; so that such containers are even less frequented by this species than in Kowloon. Tap water is laid on in all houses in Victoria, the supply being continuous for about seven months in the year, while for the remaining five months it is intermittent, but never less than two hours a day. A relatively very large number of storage vessels are kept in use during the intermittent period, but the great majority of them are not utilised during the continuous supply. At the time of Dr. Macfarlane's inspections water was plentiful, and any storage barrels in use were too full to be examined properly. In Hong Kong harbour two police collectors made 1,500 visits to the junks and Chinese cargo lighters, but they failed to find any *S. fasciata* larvae.

Dr. Macfarlane is to be congratulated upon the very thorough and painstaking mosquito survey which he has carried out.

CHALCIDOIDEA BRED FROM *GLOSSINA MORSITANS* IN NORTHERN RHODESIA.

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In connection with investigations into the life-history, etc., of *Glossina morsitans* in Northern Rhodesia, special efforts have recently been made to secure parasites of the fly. As a result, a considerable number of Chalcidoids have been bred from puparia collected between August and December of last year at Kashitu (*Ll. Lloyd*) and Mwengwa (*R. A. F. Eminson*). These interesting Hymenoptera have now been forwarded to the Imperial Bureau of Entomology by Mr. Lloyd, Chief Entomologist in Northern Rhodesia, with the parasitised puparia and some relevant notes. On this material the present report is based. The collection contains three species, representing as many widely separated groups in the superfamily Chalcidoidea. Two believed to be new are described below, the types being deposited in the British Museum.

Family Chalcididae.

Genus Stomatoceras, Kirby (1883).

Stomatoceras, Kirby, Journ. Linn. Soc. Lond., xvii, no. 98, p. 62, Pl. iv, figs. 21–23 (1883).

Genotype* *Halticella*† (sic) *liberator*, Walker, Trans. Ent. Soc. Lond. (3) i, p. 361 (1862).

In erecting *Stomatoceras*, Kirby failed to note the characteristic armature of the propodeon.‡ This omission he later supplied (Journ. Linn. Soc. Lond., xx, no. 116, p. 36, 1886); nevertheless, Ashmead (Mem. Carneg. Mus., p. 255, 1904) includes *Stomatoceras* in the section of the Haltichellinae in which the "metathorax" (*i.e.*, propodeon) is "normal, without projections," and in this error he is apparently copied by Schmiedeknecht (Wytsman's Genera Insectorum, Chalcididae, p. 49, 1909). Schulthess (Bull. Soc. Vaud. Sc. Nat., xxxv, p. 251, 1899) treats *Stomatoceras* as a subgenus of *Haltichella*, but the group included here deserves, I believe, full generic rank. The ♀♀ may be separated by the following characters :—

Antennae slender, 11 (13) jointed, the divisions of the last joint generally requiring clearing in potash for demonstration. *Scutellum* sharply bidentate, with no median furrow and differing in sculpture from the mesonotum only in the rather more closely set puncturation. *Propodeon* with one (sometimes only slightly raised) projection *before* the crescent stigma and two well developed, behind, on the ridge

* The genotype, *Stomatoceras liberator*, Walker, in the British Museum is from Port Natal (*Guienzius*). The eleventh joint of the left antenna (mounted in balsam) is distinctly twice divided.

† Spinola (1811) named his genus *Haltichella*; Walker wrote *Halticella*, which is preferable, but the change is inadmissible.

‡ In the Oxford Dictionary it is pointed out that Newman's original spelling—propodeon—is the correct Latinised form of this term, and not propodeum.

between notum and pleura. *Wings* always maculate, banded or clouded, radius and post-marginal very short and sub-equal; femora with the lower edge minutely denticulate, produced besides into two or three blunt projections.

The genus is well represented in Africa.

Stomatoceras micans, sp. nov. (figs. 1, 2).

Distinguished by the antennae (colour and narrowness); wings (pattern); legs (colour and armature); pubescence (colour and distribution) and first abdominal segment.

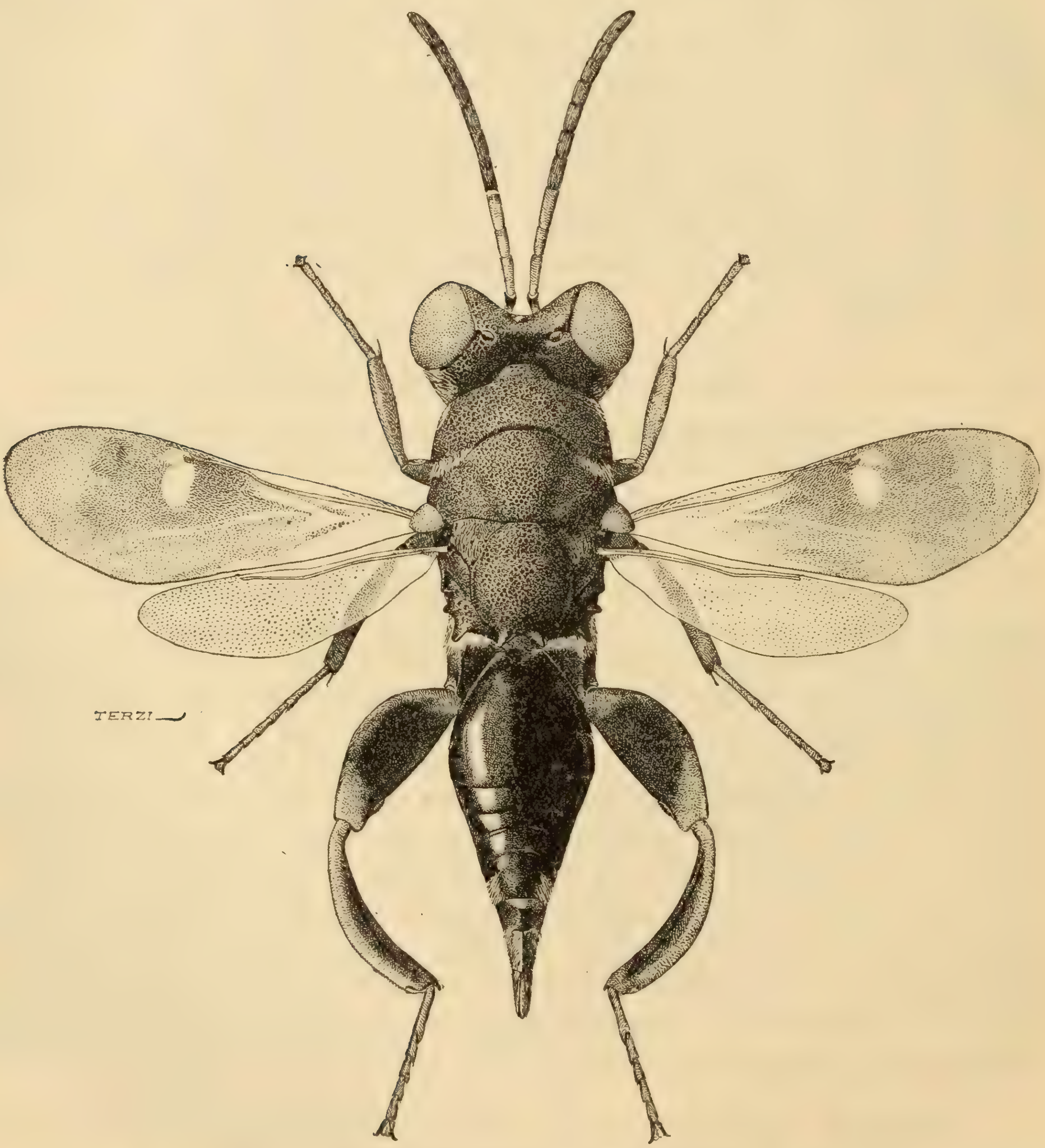

Fig. 1. *Stomatoceras micans,* Waterston, sp. n., ♀.

♀. *Head, Thorax* and *Abdomen* black; tegulae brown. Seventh tergite narrowly paler at base and middle of extreme apex; the upper edges of the sheath of the ovipositor blackish brown; viewed laterally, the abdomen is hardly so dark as from

above. *Legs* : fore and mid legs from coxae to apex of tibia reddish brown, tarsi lighter, rufous-flavescent ; hind coxae black, apex brown ; femur mainly black, with base and apex brown ; tibia externally brown, with the inner edge broadly black ; just before the apical spines this black band leaves the edge and terminates near the middle of the inside apical edge ; the lower apical angle of the tibia brown ; tarsi brown with a slight flavescent tinge, not so pronounced as in the anterior legs ; claws brownish. *Antennae* : scape (darker slightly at extreme tip), pedicel, and joints 1 and 2 of funicle brown or yellowish brown ; five to ten almost black ; the club lighter but not so pale as the scape, etc. *Wings* : the membrane of the base up to near the origin of the marginal vein is irregularly clear, though not quite hyaline ; elsewhere (save for the round clear spot at the end of the marginal vein) the wing is more or less darkly tinged. The distinctive pattern, however, is produced by the chaetotaxy (see separate account) ; veins brownish ; hind wings hyaline. *Pubescence* : on head, prothorax (at side and along anterior edge of pronotum), axillae, propodeon (pleurae and posterior edge), hind coxae (outside), pleurae of abdominal tergites 1, 2, 3 and 6 silvery white, glistening ; on the posterior edge of the pronotum and inside the parapsidal furrows rather faint yellowish ; on abdominal tergites 3 (above only), 4 and 5 (entirely), 6 (medianly), 7 and 8 are fine brown hairs ; on the ridges above the stylets the hairs are yellowish brown.

Head wide, exceeding the thorax and equalling the distance between the points of the extended tegulae ; much wider than the abdomen (10:7) ; broadly and deeply excised on the frons and occiput, so that the vertex is reduced to a rounded ridge on opposite sides of which lie the anterior and the lateral ocelli respectively ; the lateral ocelli are within their own diameter's length from the edge of the eye. The whole head (like the notum of the thorax) umbilicately punctured ; the punctures on the frons finer, especially behind the scapes.

Antennae (fig. 2, 1) set low down, with the usual semicircular flat thin process between the scrobes ; narrow and filiform, of almost the same calibre throughout. Scape (16 : 1), slightly swollen near the base, then narrowed till near the extreme apex, which is again expanded into two flanges to receive the pedicel. The pedicel is about equal to the second funicular joint, which is the longest in the funicle ; the eleventh joint or club is on clearing very distinctly biseptate, but there are no internal articulations comparable with those existing between the other funicular joints. The proportions of the joints, excluding the scape, are :—(pedicel) 18 : 11 : 18 : 13 : 13 : 12 : 13 : 11 : 9 : (club) 5 : 4 : 10. In the same ratio the width of the funicle is 6–7. Length of antennae, 2·35 mm.

Thorax normal in structure and sculpture ; scutellar teeth sharp and wide apart ; pubescence rather sparse ; on *pronotum* mainly at the sides ; on posterior edge broadly interrupted medianly ; on the *mesonotum* the pubescence is confined to a single row along the inside of the parapsidal furrows ; the axillae are completely but sparsely clothed. *Scutellum* bare. The *metanotum* is represented by two narrow, wedge-shaped sclerites with eight to ten round punctures. The teeth of the *propodeon* occur on the edge between the notum and pleura ; the first before the curved stigma is short and rather blunt, the two posterior being longer. The longest pubescence occurs between the hindmost spine and the petiole ; there is a scattered pubescence

also on the pleura of the propodeon above the hind coxa, and a much more compact patch on the outer basal half of the coxa itself.

Wings : fore wings three times as long as broad ; submarginal : marginal : radius : post marginal, 18 : 6 : 1 : 1 (when highly magnified the radius and postmarginal are roughly as 15 : 13). The submarginal vein bears about eighteen bristles from the base of the wing to the two clear transversely placed cells ; the marginal is covered with numerous scales (modified hairs) ; the radius has four cells, the last minute (fig. 2, 2). The submarginal cell has on the under side about twenty-four bristles, half-a-dozen near the base being stronger ; it is not closed, as the marginal vein does not run quite flush with the costa. Where the cell narrows there are a few short

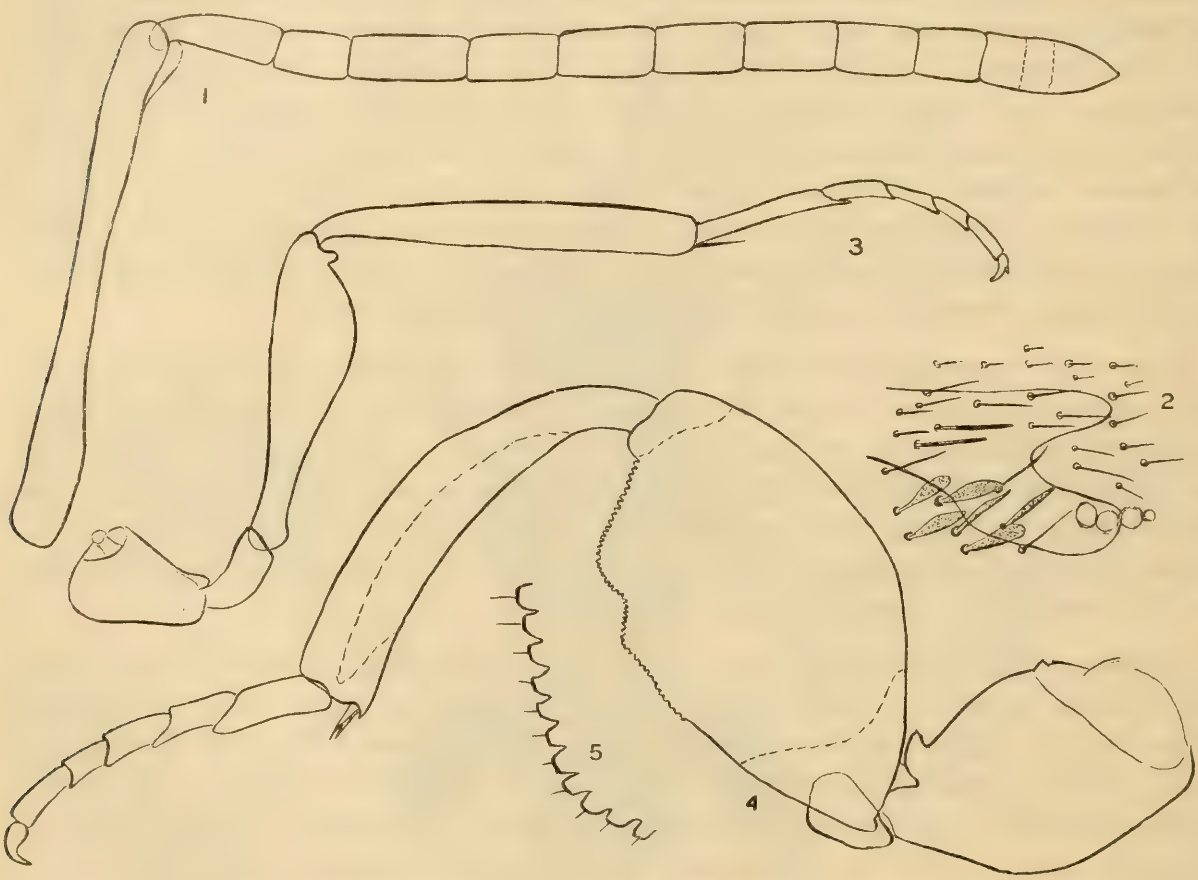

Fig. 2. *Stomatoceras micans*, ♀ ; (1) antenna ; (2) end of marginal and radius ; (3) mid leg ; (4) hind leg ; (5) lower outer edge of hind femur.

stout hairs, and scales above. The posterior margin of the wing from the base to nearly opposite the end of the submarginal is bare, but behind the submarginal and up to its mid point are three to five rows of hairs ; after this there is a broad < shaped, clear space, the lower arm short, while the upper extends nearly to the beginning of the marginal vein. The middle portion of the wing is occupied by a dark cloud, interrupted only by a large clear spot at the end of the radius and a clear line about twice the length of the marginal, which begins somewhat before the origin of that vein and runs (at one-third) parallel to the hind margin ; the depth of the cloud is due in part to the colour of the wing membrane (which is a little darker below the marginal) and again to the closely set, blackish brown

scales and short thick bristles. Besides these elements the chaetotaxy comprises also fine bristles (long and short) of two colours :—(*a*) blackish brown, clothing the apex broadly and more scattered on the under surface, and (*b*) quite hyaline and refringent, covering the clear spot below the radius, and giving the spot a silvery white appearance in direct light. Length of forewing, 2·4 mm. ; breadth, 0·8 mm. The hind wing is about four-fifths as long as the forewing ; length : breadth, 9 : 2.

Legs : the fore femur is considerably swollen and broadest before the apex ; in the mid leg (fig. 2, 3) the swelling of the femur takes place abruptly after one-half ; on the lower outer edge of the hind femur, which is minutely denticulate from the apex to about one-third from the base, there are on the posterior half two distinct, nearly equal prominences, and a third, less clearly marked, just before one half (fig. 2, 4, 5).

Proportions of Tarsal Joints.

	i.	ii.	iii.	iv.	v.	Claw.
Fore	95	55	45	40	55	25
Mid	130	65	50	40	55	30
Hind	80	75	60	50	80	45

Abdomen ovate and acutely pointed ; the first segment is the widest and about as long as wide ; it occupies rather less than half, the posterior edge lying mid-way between the insertion of the petiole and a line connecting the stylets on tergite 7. The entire surface is polished and shining, there being only a slight patch of pubescence on each of the pleurae. Second segment about as long as the fifth, and both longer than the third, while the fourth appears so much wedged in dorsally as to be reduced to a mere line in the middle ; segments 6 and 7 are again long, the former slightly shorter ; segment 7 is as long as segments 2 to 5 inclusive. The upper sheath of the ovipositor (tergite 8) is half as long as the seventh segment ; the ovipositor does not project. After the first segment the tergites are finely raised reticulate, the pattern on tergite 6 being coarsest on the distal three-fourths ; the basal one-fourth is on this tergite smooth. On the seventh tergite the stylets are placed just before one-half ; their containing depressions meet indistinctly above, and from this junction a keel stretches backwards to the posterior edge. The pleurae of all the tergites (except 1 and that partially) are covered with pubescence, the units of which are stronger and refringent on segments 2, 3 and 6 ; elsewhere the clothing is of fine hairs which are best seen in side view ; the refringent patches have a characteristic silvery gleam (see colour notes).

Length, about 4 mm. ; alar expanse, 6 mm.

NORTHERN RHODESIA : Mwengwa, 3,200 ft., one specimen bred from a pupa of *Glossina morsitans* (*R. A. F. Eminson*).

Type—a ♀.

Mr. Eminson found the puparium from which the *Stomatoceras* was bred on 6th October, 1914, in the locality where the puparia yielding *Syntomosphyrum* occurred

(see below p. 81). The date of emergence was not noted. No other specimen nor certain evidence of the recurrence of this species was secured. The *Stomatoceras* emerged from the puparium by a large irregular hole. Although other similarly fractured pupa-cases were found, Mr. Eminson thinks that the injury might have been caused in these instances by ants.

Family Encyrtidae.

Genus Anastatus, Motsch. (1859).

Anastatus, Motschulsky, Etud. Ent., viii, p. 116 (1859).

The species now described and assigned to *Anastatus* may represent a new genus. The short ovipositor and the nature of the posterior edges of the abdominal tergites preclude its being placed in *Eupelmus* or any of the nearest allies of that genus ; but the species does not run down easily into any of the presently accepted divisions of the subfamily Eupelminae, and it is only because *Anastatus* seems to offer fewer difficulties that I place this species there.

Anastatus viridiceps, sp. nov. (figs. 3, 4, 5).

♀. A pale brown insect, with darker head and banded forewings (fig. 3). *Head* : metallic green, with faint golden to coppery reflections, especially near the orbits, and on the depressed triangle between the scrobes and the anterior ocellus. Eyes purplish brown, ocelli clear. Antennae like the frons, etc., metallic green, except the scapes, which are non-metallic yellowish brown. *Thorax* and *legs* mainly clear yellowish brown. Empodia and claws darker, and a dark superior streak on mid femora, beginning at about one-third from the base and extending to the apex. The heavy spines of the mid tarsi are likewise blackish brown. The elongated mesosternum dark, metallic green. Sharply separated from the non-metallic pale pleurae, while on the notal surface all over the mid lobe and invading the lateral lobes in two narrow strips, the same metallic green coloration reappears, being strongest behind the fading ends of the parapsidal furrows, just in front of the suture, which it fails to reach. Apex of scutellum also slightly darkened and submetallic. Anteriorly the mesopleurae are covered sparsely by a glistening white pubescence. Propodeon dark, with distinct purplish metallic reflections. *Wings* : forewings mainly tinged with brown, but the submarginal cell and a transverse band from the middle of the marginal vein to the hind margin are hyaline. The apex is clear and the apical region extensively pale from about the ending of the post-marginal, but this is due in part to the lighter chaetotaxy. There is no sharp demarcation between the dark post-median and the light apical areas. Pubescence mainly brown, but round the edges of the clear median band and near the origin of the marginal is a scattered blackish pubescence, seen when the light is allowed to fall from the side. *Abdomen* : basal one-third (segments 1 and 2) semi-transparent whitish, followed by a dark median band (on tergites 3 and 4). The posterior half of the abdomen concolorous with the legs and thorax ; somewhat dusky on sternites and flanks.

Head : eyes bare (× 600, a few very minute hairs not exceeding the facets in height are visible near the edges), approximated on the vertex, where they are separated by about their own diameter (seen from in front) and by twice that distance below. The keel from the lower eye angle is well defined to the clypeal edge. Frons

entirely reticulate, with fine, even, much raised pattern. The bristles of the usual row along the orbits are weaker below, with only one to two stronger on the vertex. Ocelli in a nearly equilateral triangle; the posterior pair rather farther from one another than from the anterior ocellus. Posterior ocelli set near the eyes, the distance between them being twice that of either from the eyes. The scapes of the antennae lie in an elongate triangular depression with sharp lateral edges. This hollow thins out and is medianly sharply keeled towards the anterior ocellus, at which it ends.

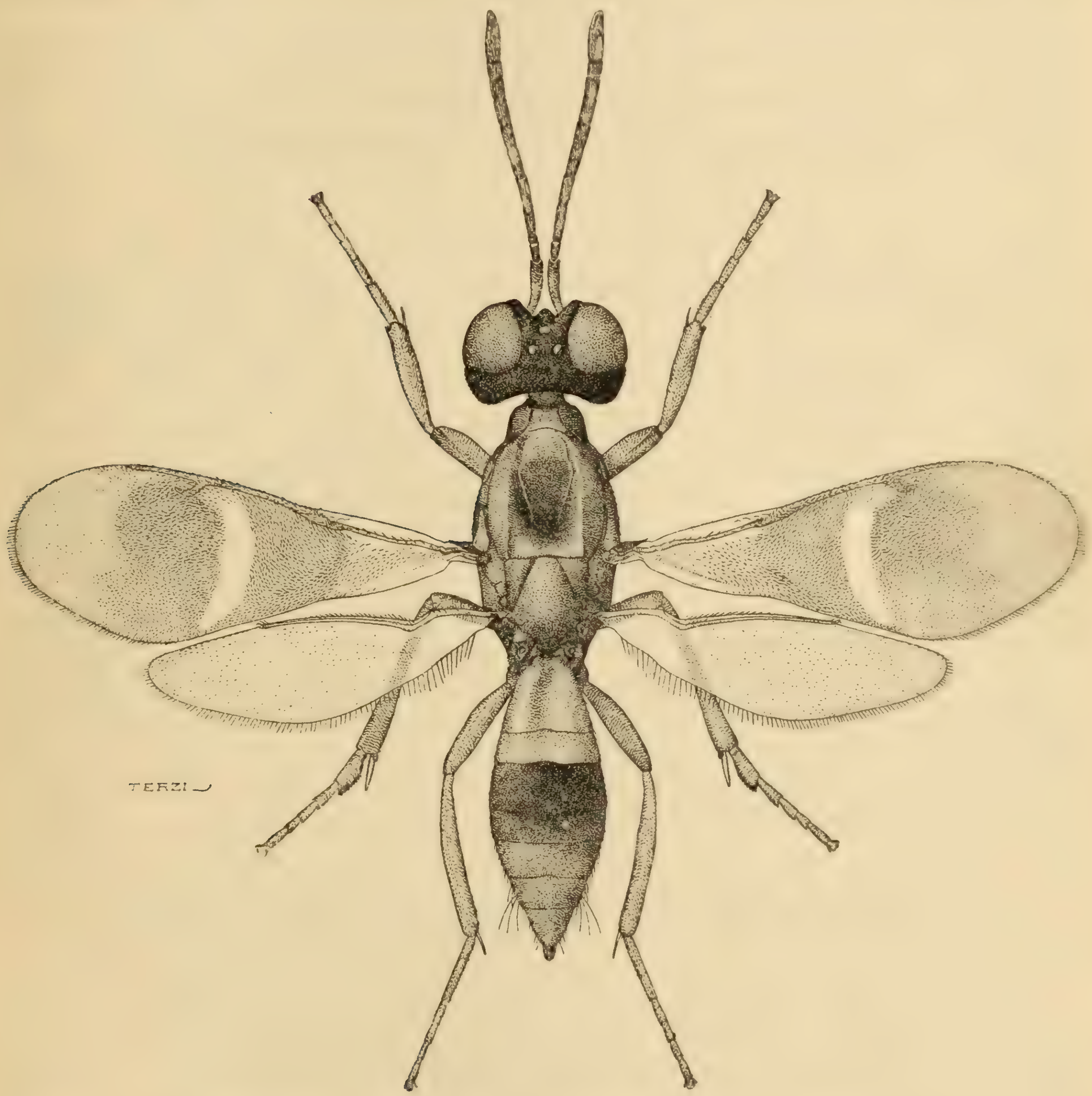

Fig. 3. *Anastatus viridiceps*, Waterston, sp. n., ♀.

The scrobes, broader than deep, rounded quadrate, with the upper inner angle slightly produced, lying one-half below the base line of the eyes. Frons, except for the orbital bristles, bare to the level of the scrobes, between which and the clypeal edge are numerous short bristles. Clypeal edge distinctly concave, with a narrow median smooth area, flanked by short ridges, bearing four hairs. No sharp occipital edge, the whole vertex being gradually rounded so that the eyes have a considerable margin behind.

Antennae (figs. 4, 5) with thirteen joints: scape, pedicel, eight funicular, three in club. Scape about five-and-a-half times as long as broad, rather narrow on basal third; reticulate, with regularly distributed short hairs on either side; one or two outer subapical median bristles stronger. Pedicel two-sevenths of the scape and twice as long as broad. From the first funicular joint to the middle of the club the antenna is steadily expanded. The third joint (first funicular) is a little narrower (3 : 4) than the pedicel and half the width of the tenth joint, while the club at its widest exceeds the third as 5 : 2. The segmentation of the club is obliquely undulated, not circular and transverse. The last joint obliquely truncated, with a membranous termination, which forms a large sense organ. The proportional lengths of the antennal joints from 3 onwards are 13 : 37 : 34 : 40 : 30 : 30 : 28 : 26, and of club 27 : 23 : 25, measured along the ventral edge. The second funicular joint (4) bears no sensoria.

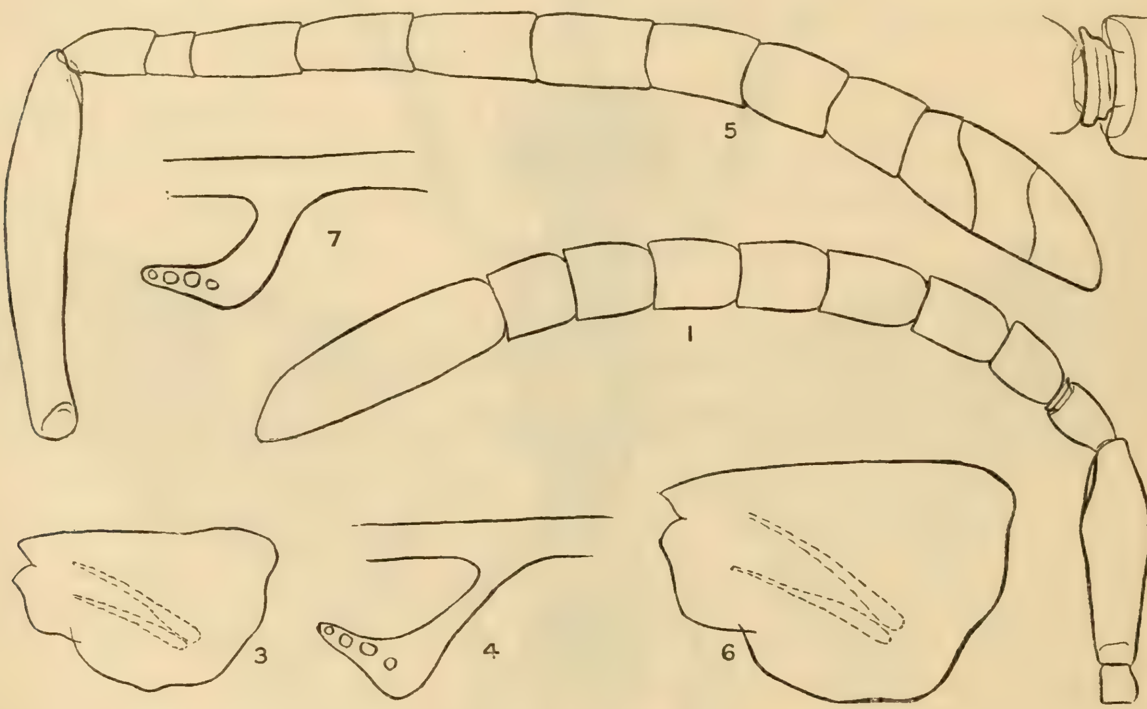

Fig. 4. *Anastatus viridiceps* : ♂.—(1) antenna; (2) ring joint; (3) mandible; (4) radius. ♀.—(5) antenna; (6) mandible; (7) radius.

Mouth-parts of the usual Eupelmine type. Labrum small, co-extensive with the smooth median area of the clypeus; bearing eight bristles. First maxilla, both stipes and mentum strongly reticulate; the former with one to two superficial and four lateral bristles. Maxillary palpus, 11 : 12 : 16 : 35; the last joint darkened and apically broadened. Labial palpus, 15 : 9 : 15; the second joint broader than long. The teeth of the mandibles are short, the outer acute, the inner broad and obtuse (fig. 4, 6).

Thorax: pronotum in two sclerites, with a narrow median membranous connection. Each protergite with a few scattered bristles forming anteriorly a row of seven to eight; two longer and two shorter bristles near the dark spiracular edging; surface of pronotum smooth, reticulate. The rest of the dorsal thoracic surface has a rather

fine strongly raised pattern, that on the scutellum and axillae so coarse as to appear honeycombed. There is a small median presutural smooth area. The incomplete, backwardly converging parapsidal furrows fade away about the middle of the mesonotum; within them posteriorly the sculpture of the mid lobe is almost as coarse as on the scutellum. The basal sutural abscissa of the scutellum is narrow - a little more than half that of either axilla. There is practically no post-scutellum, the metanotum consisting of two narrow inconspicuous sunken and slightly roughened sclerites.

Mesonotum with scattered hairs at the corners of the raised cells, two short bristles at each side opposite the middle of the axillae, and one or two more on the smooth area. After the suture no scattered hairs, but four or five bristles on each axilla, three along the outer edge and one or two on the inner, and about eight on the scutellum, two post-median and more central, and six (three, three) along the sides.

Each half of the prosternum bears numerous short bristles; the prepectus small, wedge-shaped and fused (?) with pleurae. The surface of the mesosternum and mesopleurae smooth, with striate pattern and only a few weak scattered hairs, except on the anterior third of the pleurae, which are covered with short appressed white bristles. The propodeon takes the form of two smooth triangular sclerites, narrowly united. There is some roughness below the oval, laterally-directed spiracles, and about the mid line. The pleurae are covered with many moderately long bristles.

Wings: *fore wings*, length : breadth, 5 : 2. Submarginal : marginal : radius : post-marginal, 10 : 11 : 2 : 5. End of radius triangular, with four separated cells (fig. 4, 7). Length, 1·8 mm.; breadth, ·68 mm. The submarginal bears up to its junction with the marginal, seven to eight bristles, and parallel to this row are numerous minute hairs on the submarginal cell. The apex of this cell carries below sixteen to eighteen black recurved strong bristles of moderate length, crossing with the bunch of short spines at and on the junction of the veins. These spines are the heaviest units of the chaetotaxy. Similar short thick bristles occur on all the infuscated areas of the wings, except towards the apex. The scattered black bristles round the clear median band are heavier, but not structurally different from the brown ones elsewhere. Within the area subtended by the submarginal the chaetotaxy inclines parallel to the radius; beneath the marginal the bristles are at right angles to the radius; elsewhere the pubescence is erect or sub-erect. *Hind wings* over three times as long as broad. Submarginal : marginal, 5 : 8. Posterior cilia sparse; hairs of the disk short, longer near the apex. Marginal cell open to the hooks, with numerous bristles over the entire length. Length, 1·3 mm.; breadth, ·4 mm.

Legs: unless otherwise stated, any joint or aspect (*i.e.*, posterior or anterior) of a joint is covered with evenly spread, often close, subequal short bristles. *Fore legs* with the coxae large, hardly deeper than wide, broadly attached to the sternum; apical collar narrow, anterior surface reticulate; posterior surface bare, except at outer apical angle, where a patch of bristles occurs, the more distal stronger; above the patch (*i.e.*, basally) the surface is smooth, reticulate again posteriorly. Trochanter long and narrow (two-thirds of the coxa), the upper anterior two-thirds bare. Femur not swollen, medianly a little decurved, reticulation moderate and drawn out; numerous short bristles along the entire dorsal edge, and narrowly on the anterior face (the latter bristles ceasing towards the base), the

lowermost bristles longer, forming a row parallel to the dorsal edge on apical half of tibia and then sloping gradually to the lower basal angle; on the ventral third of the anterior aspect, there is a subventral row (seven to eight) of scattered bristles, and many more below, more closely set, so that twelve to fourteen appear on the ventral edge itself. Mid anterior aspect of tibia bare; upper apical angle strongly chitinised, with two short peg-like spines; ventral apical spur five-sevenths of first tarsal joint; anterior apical comb of seven to eight spines, confined to the ventral half; one or two of the posterior subapical median bristles much stouter. First tarsal joint ventrally concave; antero-ventral edge with a closely set comb of twenty-five spines, while on the postero-ventral edge are eight to ten stouter spines, wider apart; proportions of tarsal joints and claw, 70 : 50 : 35 : 30 : 40+20. *Mid legs* with the coxa longer than broad (9 : 7), oblong, externally bare and weakly reticulate; on inside, near the trochanters, an oval patch of minute bristles (about forty) and one or two longer bristles at or near the edges. Trochanter quadrate (6 : 5), with a patch of bristles above and a transverse row of four longer bristles below. Femur depressed, gradually expanded from base to apex, bare below, except for a median basal row of about six bristles, which ends just beyond the commencement of the median dorsal dark streak (see colour notes); apically the femur extends in a flattened edge on each side of the tibia. Tibia apically a little expanded from beyond one-half; four to six peg-like spines on anterior apical angle, one stronger than the others; the posterior spine heavy, and as long as the first tarsal joint. The first tarsal joint bears on each side ventrally eleven to thirteen heavy spines, the second four to six, the third one to two, the fourth one; when these plantar edges are unequally armed, the anterior has the fewer spines; the proportions of the tarsal joints are, 65 : 55 : 40 : 35 : 50+15. *Hind legs* with numerous bristles on the outer anterior two-thirds of the coxa, two subapical on the median ridge much longer. Femur posteriorly almost bare, save for a submedian row (fifteen to sixteen) of bristles. Tibia with the posterior apical comb of about twelve spines completely transverse; the spur one-third of the first tarsal joint; the posterior subapical spines somewhat stout. Proportions of tarsal joints, 120 : 65 : 45 : 40 : 50+20.

Abdomen: On drying after immersion in spirit (in which the hind edges of the tergites are nearly invisible) the abdomen shrinks considerably and its true shape becomes debatable. In life it is probably broader on the whole, and widest more posteriorly than in Mr. Terzi's carefully executed figure. The apparent length of the tergites indicated are, through overlapping, somewhat different from the proportions of the same sclerites dissected off and measured in balsam. First and second tergites weak, almost membranous; the first most deeply incised, the succeeding tergites merely sinuate. Tergites 1 to 5 bare medianly, save for a transverse median row of seven to eight very short bristles, which are not developed on 1 and 2. On the pleural flaps, tergite 1 bears a patch of bristles anteriorly and a short row behind; tergite 2 has only a few posterior bristles at the sides; all the overlaps of tergites 3 to 5 are covered with closely set, short bristles. The posterior two-thirds of tergite 6, and all of tergite 7, covered with bristles. The spiracle is minute and circular, the stylet oval, with four long bristles. Sternites 1 to 5 medianly more or less membranous, and posteriorly incised. Sternite 1 bare; 2 to 4 with a posterior row of about twelve bristles, and other shorter ones in front;

sternite 5 medianly deeply cleft, and where not overlapped by the tergite, entirely covered with short bristles. The ovipositor does not extend beyond the non-projecting sheath ; the fixed base of the sheath is twice as long as the free portion ; the apical one-twelfth of the ovipositor is serrate, the teeth being not opposite, but developed from the sides alternately. *Length*, about $2\frac{3}{4}$ mm. ; alar expanse, over $4\frac{1}{4}$ mm.

♂. Prevailingly blackish, with unclouded wings. *Head* : eyes as in ♀, genae and frons brilliant, very dark metallic blue, greenish between the scapes ; on the vertex the latter tinge prevails. Antennae dark, with metallic green reflections, only the ventral edge of the scape narrowly non-metallic pale brown. *Thorax* : pro- and meso-nota (up to the suture) metallic blue green, with a bronzy tint on the mid lobe. Axillae and scutellum darker, duller, with dim coppery reflections. *Legs* : fore coxae metallic blue-black, mid and hind coxae purplish black. All femora and hind tibiae blackish. All trochanters, fore and mid tibiae (the latter obscurely) pale. Tarsi pale, with last joints darker. *Propodeon* and *abdomen* dark blue to violet, metallic blue reflections on former, the latter only faintly metallic or non-metallic.

Head : eyes relatively further apart on the vertex than in the ♀ ; the distance in proportion to the diameter of the eye from in front is 5 : 3 ; at the lower angle the proportion is 5 : 2. The scrobes are set higher up in this sex, nearly clear of the base line of the eyes. The margins of the depressed triangle in which the scapes lie, and also the apical median keel, are not distinctly defined—the outlines being rather rounded. There is a whitish pubescence above the scrobes. Mouth-parts as in the ♀, but the last joint of the maxillary palpus relatively shorter.

Antennae (fig. 4, 1) eleven-jointed, differing from those of the ♀ in that the club is unsegmented and the first funicular is a ring joint (fig. 4, 2). Scape about three-and-a-half times as long as broad ; rather wide near the base and expanded distally ; considerably excavated for the pedicel (one-third). Pedicel narrow (7 : 4). Seven normally developed funicular joints, besides the ring joint, all longer than broad. The antenna expands so gradually that the club only slightly exceeds (8 : 7) the tenth joint, and is not more than half as broad again (3 : 2) as the first normal funicular joint (fourth). On the inside of the funicle and club are numerous sensoria, about seventy on the club alone. Proportions of last eight antennal joints, 20 : 25 : 30 : 27 : 27 : 24 : 24, and club, 87.

Thorax : *pronotum* hardly visible from above, largely concealed behind the swollen occiput ; almost perpendicular, not horizontally porrect as in the ♀ ; distinctly reticulate, with scattered hairs all over and an irregular posterior row of six bristles on each protergite. *Mesonotum* with complete furrows meeting the suture at the middle of the axillae. Basal scutellar abscissa narrow, barely half that of axilla. Mid and lateral lobes with a regular raised reticulation and numerous short, evenly distributed hairs. Middle of scutellum and inner sides of axillae with the same pattern as the mid lobe, etc., but the outer sides of the axillae and scutellum have a striate reticulate pattern. Axilla with eight to ten bristles. Scutellum with many more hairs than the ♀ (twenty to twenty-four in all), besides the two clear median pustules which may not be setigerous. *Metanotum* normal, all three parts reticulate, the post-scutellum coarsely so ; mesophragma long and not reduced as in the ♀. Mesopleurae with a distinct furrow. A quadrate sclerite (? episternite) distinguishable below the wings. Mesosternum posteriorly with an irregular median double,

and a lateral single, row of hairs reaching to about one-half. Sternum and pleurae smooth or faintly reticulate, with a few inconspicuous hairs. (In the ♀ this region has a strong, silvery pubescence). Prepectus large, coarsely reticulate. *Propodeon* normal, spiracle more roundly oval than in the ♀. Pleurae below spiracle boldly reticulate, with a few weak hairs, not forming a conspicuous patch as in the ♀.

Fig. 5. *Anastatus viridiceps,* Waterston, sp. n., ♂.

Wings: *fore wings* rather more than twice as long as broad, with a scattered pubescence of equal calibre, wanting only below the junction of marginal and submarginal veins. Submarginal: marginal: radius: post-marginal, 5 : 3 : 1 : 2. Length, 1·3 mm.; breadth, ·6 mm. The submarginal carries ten to twelve bristles. In the cell a double row of short bristles, those at the apex not markedly stronger nor crossing with others on marginal vein. *Hind wings* similar to those of ♀; three times as long as broad. Submarginal to marginal, 3 : 2. Length, ·9 mm.; breadth, ·3 mm.

Legs: *fore legs* with the femur a little swollen, not decurved, both dorsal and ventral edges convex; chaetotaxy essentially as in the ♀, but the bristles are longer and form ventrally a distinct row (seven to eight); on the anterior face the bristles descend to one-half, reducing the bare area to a streak; two short heavy spines at upper apical angle, and a transverse comb of six spines. Only the anterior edge

of first tarsus excavated, with a comb of sixteen to eighteen spines; the straight posterior edge bears seven to eight; proportions of tarsal joints, 50 : 30 : 25 : 20 : 30+20. *Mid leg* lacking the internal oval patch of spines on the coxa. Femur and tibia normal (*i.e.*, antero-posteriorly compressed), femur not expanded, posteriorly smooth and bare, except for three bristles in a median line from the base, the last standing at about one-half. Tibia without upper apical short peg like spines; one apical bristle below the normal spur is strong. Tarsus normal, without heavy spines or thickening of any joint; proportions of tarsal joints, 55 : 35 : 25 : 20 : 30+15. *Hind legs* with the tibia slightly flattened but not apically expanded, no upper apical heavy spines; posterior comb with fourteen to fifteen spines. Proportions of tarsal joints, 65 : 37 : 28 : 22 : 30+20.

Abdomen like that of the ♀, depressed above and carinate below; all tergites equally sclerosed, and none posteriorly emarginate. The surface smooth along the median line, but the pattern reappearing at the sides. Only one posterior row of bristles on tergites 1 (three, three) and 2 (six, six); on 3 and 6 there is a complete double row of bristles, and one or two more at the sides; tergite 7 has one or two hairs outside the stylet and about fourteen (seven, seven) between; tergites 6 and 7 are also shagreened at the sides, with numerous microscopic scales. Tergites 2 to 7 are equal, and 1 is half as long again as the others. The stylet bears one long and three or four shorter bristles. Length, about 1·8 mm.; alar expanse, 3–3½ mm.

NORTHERN RHODESIA: Kashitu, 3♂♂, 6 ♀♀, bred from puparium of *Glossina morsitans* (*Ll. Lloyd*).

Type—a ♀.

The *Glossina* puparium was taken on 11.xi.14, and the parasites emerged four days later. Besides the above complete examples 2 ♂♂ and 2 ♀♀ were enclosed in a fragmentary condition, these having been kept alive by the collector in an attempt to propagate the species. In his covering letter (30.xii.14) Mr. Lloyd remarks that "in all, 9 ♀♀ and 6 ♂♂ emerged through a small round hole on the dorsal surface, a little in front of the anal cap; . . . . copulation occurred shortly after emergence and the males lived only a day or so." Considering the care taken in rearing these parasites, the broken condition (noted by Mr. Lloyd before despatch) of four examples which were kept alive for breeding purposes, seemed noteworthy. I have since seen ♂♂ of another *Anastatus* when confined in a tube with a ♀ bite one another so severely that a leg was partially torn off.

Family EULOPHIDAE.

Genus SYNTOMOSPHYRUM, Först.

Syntosmophyrum glossinae, Wtrst.

S. glossinae, Waterston, Bull. Ent. Res. v, pt. 4, p. 365, figs. 14–16 (1915).

A tube full of fragments of this species has been received, concerning which Mr. Eminson writes, "about thirty specimens found on August 21st, 1914, which had emerged from a single pupa of *G. morsitans*. As will be seen, the parasites emerged through a minute hole in the pupa-case. Since that date three specimens of pupa-cases similarly attacked have been found. The pupa was collected on June 1st within a mile of the Kafue R., near Mwengwa."

This is a very slightly smaller form than the type, which was bred from *Glossina palpalis*, the abdomen (♀) being entirely dark and the second mid tarsal joint in many examples about one-seventh longer. In all other respects the agreement is complete. This is the material referred to in Bull. Ent. Res., v, p. 382 (1915).

The nature of the relation of these three Chalcidoids to *Glossina morsitans* is not yet determinable. The *Anastatus* is probably a true parasite and therefore a beneficial insect; of the *Stomatoceras* nothing can be affirmed. The *Syntomosphyrum* belongs to a group containing both parasites and hyperparasites, and may be either a useful controller of the fly, or a useless destroyer of a natural enemy.

[Including the foregoing species, we now know of seven insects which are parasitic on *Glossina*, five being Hymenoptera and two Diptera. The following is a list of them:—

Parasite.	Host.	Locality.	Collector.
MUTILLIDAE—			
Mutilla glossinae, Turn. ..	*G. morsitans*	N. Rhodesia	R. A. F. Eminson.
PROCTOTRUPIDAE—			
Conostigmus rodhaini, Beq.	*G. palpalis*	Katanga, Belgian Congo	J. Bequaert.
CHALCIDIDAE—			
Stomatoceras micans, Wtst.	*G. morsitans*	N. Rhodesia	R. A. F. Eminson.
ENCYRTIDAE—			
Anastatus viridiceps, Wtst.	,,	,,	Ll. Lloyd.
EULOPHIDAE—			
Syntomosphyrum glossinae, Wtst.	*G. palpalis* *G. morsitans*	Uganda .. N. Rhodesia	Dr. G. D. H. Carpenter. R. A. F. Eminson.
BOMBYLIIDAE—			
Thyridanthrax abruptus, Lw.	*G. morsitans*	S. Rhodesia	R. W. Jack.
Villa lloydi, Aust.	,,	N. Rhodesia	Ll. Lloyd.

—ED.]

COLLECTIONS RECEIVED.

The thanks of the Imperial Bureau of Entomology are due to the following gentlemen, who have kindly presented collections of insects (received between 1st October and 31st December, 1914) :—

Dr. W. M. Aders :—3 Culicidae, 3 Culicid larvae, 2 Hippoboscidae, 2 Coleoptera, 2 Lepidoptera, and 2 Ticks ; from Zanzibar.

Capt. C. H. Armitage, C.M.G., D.S.O., Chief Commissioner :—55 Culicidae, 1 *Phlebotomus*, 5 *Tabanus*, 77 *Glossina tachinoides*, 4 other Diptera, and 4 Hymenoptera; from the Northern Territories, Gold Coast.

Dr. Andrew Balfour, C.M.G., M.D., Director-in-Chief, Wellcome Bureau of Scientific Research :—20 Hymenoptera, 27 Mallophaga, 25 Orthoptera, 6 Mites, and 25 Spiders ; from Bogota, Colombia.

Mr. G. E. Bodkin, Government Economic Biologist :—1 Fly, 28 Hymenoptera, 10 Coleoptera, 4 Lepidoptera, 53 Termites, 62 Mallophaga, 1 sp. of Coccidae, 6 Rhynchota, 2 Orthoptera, 6 Thysanura and 1 Spider ; from British Guiana.

Mr. John R. Bovell, Superintendent of Agriculture :—1 *Tabanus*, 112 Hymenoptera, 13 Coleoptera, 11 Lepidoptera, 14 slides of Parasitic Hymenoptera, Ants, Termites, and Coccidae ; from Barbados.

Mr. E. C. Chubb, Curator of the Durban Museum :—192 Culicidae, and 84 Odonata ; from Natal.

Dr. P. A. Clearkin, W.A.M.S. :—15 Culicidae, 2 *Tabanus*, 5 *Glossina*, 1 Syrphid, and 9 Ticks ; from Sierra Leone.

Dr. J. F. Corson, W.A.M.S. :—54 Ticks ; from Northern Territories, Gold Coast.

Dr. J. B. Davey, M.O. :—15 Butterflies, and 91 Moths ; from Blantyre, Nyasaland.

Dr. G. C. H. Davies, Government Medical Officer :—31 Culicidae ; from Tulagi, British Solomon Islands.

Mr. C. O. Farquharson, Government Mycologist :—26 Coleoptera, 1 Bug, and an Embiid nest ; from Calabar, Southern Nigeria.

Dr. G. A. Finlayson, Government Pathologist :—152 Culicidae, 1 *Tabanus*, 9 other Diptera, and 1 Moth ; from Singapore.

Mr. Ernest Hargreaves :—300 cotton-boll weevils ; from Louisiana, U.S.A.

Dr. F. S. Harper, W.A.M.S. :—13 Dipterous larvae, and 13 Ticks ; from Northern Territories, Gold Coast.

Mr. Gerald F. Hill, Government Entomologist :—44 Diptera, 3 Dipterous larvae, 5 Dipterous pupae, 1 Flea, 64 Hymenoptera, 3 Hymenopterous pupa cases, 10 Coleoptera, 8 Lepidoptera, 2 species of Coccidae, 16 other Rhynchota, 5 Orthoptera, and 20 Collembola ; from the Northern Territory, Australia.

Imperial Department of Agriculture for the West Indies :—23 Coleoptera ; from Barbados.

Mr. Rupert W. Jack :—54 Lepidoptera ; from Salisbury, Rhodesia.

Dr. R. Stewart MacDougall :—3 Chalcids ; from Scotland.

Dr. J. W. Scott Macfie, W.A.M.S. :—14 Culicidae, 8 *Tabanus*, 1 *Glossina*, 1 other Dipteron, 11 larvae of *Cordylobia*, 14 Siphonaptera, 7 Coleopterous larvae, 34 *Hemimerus*, and 20 Ticks ; from Accra, Gold Coast.

Mr. J. C. Moulton, Curator of the Sarawak Museum :—208 Culicidae and 20 Chironomidae ; from Sarawak, Borneo.

Mr. A. Rutherford, Government Entomologist :—5 Culicidae, 76 other Diptera, 9 Hymenoptera, 66 Coleoptera, 77 Lepidoptera, 35 Rhynchota, 126 Thrips, and 4 Orthoptera, from Ceylon.

Dr. J. J. Simpson :—1 Mosquito, 1 *Hippocentrum*, 14 *Tabanus*, 1,255 *Glossina*, 1 *Auchmeromyia*, 35 Hippoboscidae, 111 other Diptera, 63 Hymenoptera, 75 Coleoptera, 14 Lepidoptera, 3 Planipennia, 1 *Bittacus*, 8 Rhynchota, 6 Odonata, 7 Orthoptera, 222 Ticks, and 1 other Arachnid ; from Northern Territories, Gold Coast.

Mr. Cyril Strickland :—210 Culicidae ; from the Federated Malay States.

Mr. F. W. Urich, Government Entomologist :—6 Coleoptera ; from Trinidad, British West Indies.

Dr. John Y. Wood, W.A.M.S. :—465 Culicidae, a large number of Culicid larvae, 8 *Simulium*, 9 *Hippocentrum*, 1 *Tabanus*, 24 *Haematopota*, 253 *Glossina*, 46 *Stomoxys*, 3 other Diptera, and 2 Beetles ; from Sierra Leone.

VOL. VI. Part 2.—pp. 85-204.

SEPTEMBER, 1915.

BULLETIN OF ENTOMOLOGICAL RESEARCH

ISSUED BY THE IMPERIAL BUREAU OF ENTOMOLOGY.

EDITOR: THE DIRECTOR.

LONDON:

SOLD BY

DULAU & Co., Ltd., 37, SOHO SQUARE, W.

Price 4s. net.

IMPERIAL BUREAU OF ENTOMOLOGY.

HONORARY COMMITTEE OF MANAGEMENT.

ON THE ETHIOPIAN FRUIT-FLIES OF THE GENUS DACUS.

By Prof. M. Bezzi,

Turin, Italy.

The rather numerous Ethiopian species of *Dacus* (*s.l.*) are very homogeneous owing to their reduced chaetotaxy and the very simple pattern of the wings ; they have no praescutellar bristles, only a scutellar pair, and very often only two supra-alar bristles, the anterior one being wanting. There are no species with a stalked abdomen, or with spinose femora, or with elongated antennae, or with banded wings.

In the more numerous and differentiated Oriental species the praescutellar bristles are, on the other hand, usually present, and very often there are two pairs of scutellar bristles ; the anterior supra-alar bristle is almost always present. I have therefore separated the Oriental (and Australian) species into the two genera *Bactrocera* (with banded wings) and *Chaetodacus* (with the wings not banded) ; and recently I have added the new genus *Monacrostichus* for the species with elongate antennae, spinose femora and stalked abdomen, and which also lack the praescutellar bristles.

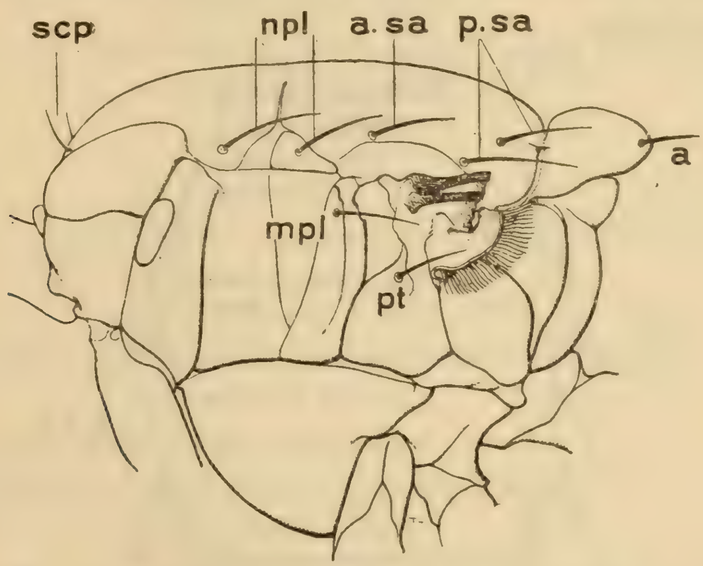

Fig. 1. Side view of the thorax of a *Dacus*, to show the chaetotaxy :—*scp*, scapular bristles ; *npl*, notopleural bristles ; *mpl*, mesopleural ; *pt*, pteropleural ; *asa*, anterior supra-alar ; *p.sa*, posterior supra-alar ; *a*, apical bristles.

It is interesting to note that there is also a small but remarkable difference in the sexual wing-dimorphism. In the males of the Oriental species the wing shows on the hind border at the end of the anal vein a deep sinuosity, the third posterior cell being therefore produced like a second axillary lobe ;* the males of the Ethiopian

* This sexual dimorphism was first described by Prof. de Meijere (*Tijdschr. Entom.*, xli, 1908, p. 127) and subsequently by Hendel (*Supplem. entom.*, i, 1912, p. 13), both working on Oriental species. But there are some true *Chaetodacus* without this lobe, such as *C. garciniae*, Bezzi, and *C. bipustulatus*, Bezzi ; *C. cucumis*, French, has no lobe, but also no praescutellar or anterior supra-alar bristles, and is therefore a true *Dacus* (*s. str.*).

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species have this character wanting or very little developed. The Oriental species with no praescutellar bristles (*Monacrostichus* and related forms) have also the hind border of the wings not indented at the end of the anal vein. It seems therefore that there is some correlation between the presence of the praescutellar bristles and the presence of the supernumerary lobe in the male.

The attempt to divide the Ethiopian species into the two genera *Dacus* (*s. str.*) and *Leptoxyda*, seems to be at present not satisfactory, although accepted by Hendel in his recent synopsis of the genera of the Trypaneïds (*Wien entom. Zeitung*, xxxiii, 1914, p. 74). It is indeed very difficult to find a dividing line between the species with free and those with fixed abdominal segments, and between the species with a flattened ovipositor and those in which it is cylindrical. Therefore I have not adopted this division in the present paper. On the other hand, I have found a better character for dividing the Ethiopian species in the thoracic chaetotaxy. Some species, which are usually of larger size, have three supra-alar bristles, the anterior one being developed like the others; I propose to call this group *Tridacus*, subgen. n. The remaining species, which are smaller, have no anterior supra-alar bristle; and as they contain *D. oleae*, I will reserve for these the name *Dacus* (*s. str.*). With this later group the genus *Leptoxyda* must be considered synonymous, unless it be regarded as distinct, with the single typical species *longistylus*.

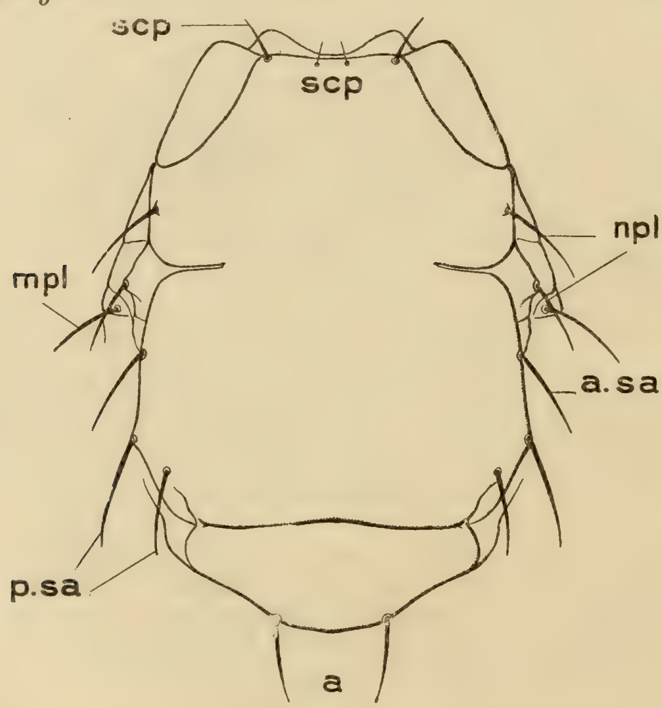

Fig. 2. Dorsal view of the thorax of a *Dacus*, to show the chaetotaxy:—*scp*, scapular bristles; *npl*, notopleural bristles; *mpl*, mesopleural; *a.sa*, anterior supra-alar; *p.sa*, posterior supra-alar; *a*, apical bristles.

The Ethiopian species of *Dacus* (*s. l.*) are not yet well known, but rather numerous forms have been described; there are also three tables of determination (without including the very incomplete one by Dr. Sack, 1908), two given by me in 1908 and 1909, and one by Dr. Speiser in 1910.

The known species are as follows :—

I. Wings with a rounded brown spot at the end, which reaches the fourth vein (fig. 4).

1. *lounsburyi*, Coquill.
2. *sphaeristicus*, Speis.
3. *fuscovittatus*, Grah.

II. Wings with a very broad brown costal border, which reaches at least the middle of the first posterior cell (fig. 5).

4. *fuscatus*, Wied.
5. *nebulosus*, Walk.
6. *armatus*, F.
7. *bivittatus*, Big.
   pectoralis, Walk.
   bipartitus, Grah.
   cucumarius, Sack.

III. Wings with a narrow costal border, not extended over the third vein.

1. Two yellow hypopleural spots.*

(A) Hypopleural spots broad and contiguous, forming a single spot (fig. 6).

(*a*) Face without black spots.

8. *immaculatus*, Coq.

(*b*) Face with two black spots ; wings without brown anal stripe.

9. *longistylus*, Wied.
   testaceus, Macq.
   kingi, Frogg.
10. *sexmaculatus*, Walk.

(*c*) Face with two black spots ; wings with a brown anal stripe.

11. *punctatifrons*, Karsch.
12. *vertebratus*, Bezzi.

(B) Hypopleural spots small and separated (fig. 11).

13. *flavicrus*, Grah.

2. Hypopleura with a single yellow spot (fig. 7).

(A) Face not black spotted, entirely yellow.

14. *annulatus*, Beck.
15. *semisphaereus*, Beck.
16. *brevistriga*, Walk.
17. *scaber*, Loew.
18. *binotatus*, Loew.

(B) Face entirely black.

19. *inornatus*, Bezzi.
   modestus, Bezzi.

(C) Face with two black spots.

(*a*) Wings with only a dark apical spot, without costal border.

20. *oleae*, Gmel.
21. *mesomelas*, Bezzi.
22. *bistrigulatus*, Bezzi.

* Of these spots, one is on the hypopleura and the other is on the sides of the mesophragma ; this latter only may be absent.

(*b*) Wings with a more or less distinct complete costal border.
23. *bistrigatus*, Loew.
24. *ciliatus*, Loew.
25. *sigmoides*, Coq.
26. *brevis*, Coq.
27. *brevistylus*, Bezzi.
28. *africanus*, Adams.

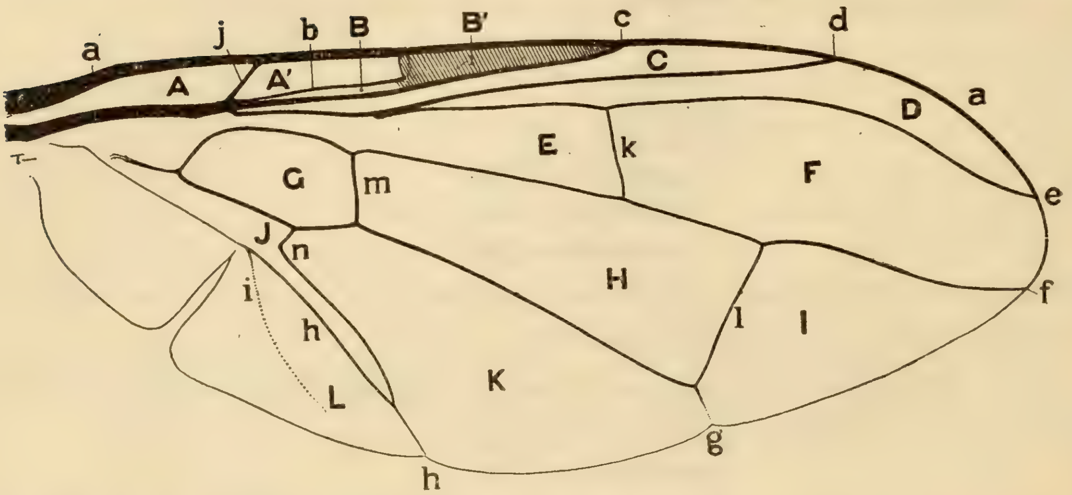

Fig. 3. Wings of *Dacus* :—Veins : *a*, costa ; *b*, auxiliary vein ; *c*, first longitudinal ; *d*, second longitudinal ; *e*, third longitudinal ; *f*, fourth longitudinal ; *g*, fifth longitudinal ; *h*, sixth longitudinal ; *i*, axillary ; *j*, humeral cross-vein ; *k*, anterior cross-vein ; *l*, posterior cross-vein ; *m*, basal cross-vein ; *n*, anal cross-vein. Cells : A, A', costal cell ; B, subcostal cell ; B', stigma ; C, marginal cell ; D, submarginal ; E, first basal ; F, first posterior ; G, second basal ; H, discoidal ; I, second posterior ; J, anal ; K, third posterior ; L, axillary cell.

In a collection of Ethiopian *Dacus* which I have received for study from the Imperial Bureau of Entomology, I have found a number of species ; and by adding to them those in my collection, I can give the following table for the species known to me :—

1 (20). Thorax with three supra-alar macrochaetae, the anterior one being well developed ; species more robust and of larger size (8–12 mm., but usually 9–12 mm.), with the wing pattern well developed and often very broad (*Tridacus*, subgen. n.).

2 (13). Wings with the brown costal border extended to the middle of the first posterior cell, or even to the fourth vein, or sometimes with a broad brown spot surpassing the fourth vein.

3 (6). Wings with a broad rounded brown spot, filling almost the whole of the first posterior cell and extending to the upper part of the second posterior cell ; species of greater size (10–12 mm.), with no yellow humeral spot and with the yellow metapleural stripe very narrow.

4 (5). Yellow spot on the hypopleura well developed and rather broad ; thorax with three yellow stripes behind the suture ; scutellum darkened above.
1. *lounsburyi*, Coq.

5 (4). No distinct hypopleural spot ; thorax without yellow stripes ; scutellum entirely yellow. . . . . 2. *sphaeristicus*, Speis.

6 (3). Wings without such a spot, but with the brown fore border extended to the fourth vein or to the middle of the first posterior cell; species of smaller size (8–9 mm.), with a distinct humeral spot and a very broad mesopleural stripe.

7 (10). Two yellow hypopleural spots; facial black spots always separated.

8 (9). Humeral calli entirely yellow; the three yellow thoracic stripes rather broad; facial black spots reaching the epistome in a point; ovipositor as long as the abdomen . . . . 3. *armatus*, F.

9 (8). Humeral calli brown, with only a small yellow spot on the fore corner; thoracic post-sutural stripes narrow, the middle one often indistinct; facial spots rounded and removed from the epistome; ovipositor short . . 4. *bivittatus*, Big.

10 (7). A single hypopleural spot; humeral calli entirely of a yellowish white colour; facial spots often united, chiefly in the male; hind femora entirely yellow; fourth longitudinal vein straight.

11 (12). Brown fore border of the wing not reaching the fourth vein, but there is a brown stripe along this vein; three post-sutural stripes on thorax; frons entirely yellow in the middle. . . . . 5. *momordicae*, nom. nov.

12 (11). Brown fore border extended without interruption to the fourth vein; middle thoracic stripe wanting; frons dark brown with yellow spots. 6. *eburneus*, sp. n.

13 (2). Wings with the brown fore border not extending over the third longitudinal vein, or doing so only at apex, sometimes without any dark border and only with a brown apical spot.

14 (15). Scapular bristles thin and rudimentary; hypopleural and humeral spots wanting; mesopleural stripe very narrow; scutellum entirely brown; no facial black spots; wings broadly yellow towards the middle, with a blackish spot at end of third vein and a brown stripe along the anal vein. . . 7. *xanthopterus*, sp. n.

15 (14). Scapular bristles strong and long; species without the preceding characters; face always with black spots; wings not yellow, but with the small cross-vein more or less infuscated.

16 (17). A single hypopleural spot; humeral calli brown, with a narrow, less distinct yellowish spot on the fore corner. . . . . 8. *humeralis*, sp. n.

17 (16). Two hypopleural spots; humeral calli entirely yellow or almost so.

18 (19). The two hypopleural spots are very small and broadly separated; humeral calli margined with black; facial black spots very small; wings with a pale fore border and without apical spot. . . . . 9. *disjunctus*, sp. n.

19 (18). Hypopleural spots broad and contiguous; humeral calli entirely yellow; facial spots broad and rounded; wings with a blackish fore border and with a dark apical spot extending over the third vein. . . . . . 10. *punctatifrons*, Karsch.

20 (1). Thorax with only two supra-alar macrochaetae, the anterior one being entirely wanting; smaller species (5–10 mm., but usually 5–8 mm.), with the wing pattern reduced to a narrow fore border or to an apical spot, sometimes entirely wanting (*Dacus*, s. str.).

21 (22). Face without black spots; two contiguous hypopleural spots; wings with a black stigma and a small black spot at the end of the third vein. 11. *immaculatus*, Coq.

22 (21). Face always with black spots, or even entirely black.

23 (30). Wings without anal brown stripe.

24 (29). A single hypopleural spot.

25 (26). Wings without apical spot at the end of the third vein, with a black stigma only; face wholly black; abdomen and ovipositor entirely black, the former with fused segments. . . . . 12. *inornatus*, Bezzi.

26 (25). Wings with a distinct apical spot; face with the two usual black spots; abdomen reddish, with or without black spots.

27 (28). Apical spot of the wings isolated; thorax dark brown, with the middle scapular bristles distinct; abdominal segments separated. . 13. *oleae*, Gmel.

28 (27). Apical spot united with a narrow but distinct black fore border; thorax rufous, like the whole body, with indistinct middle scapulars; abdominal segments fused. . . . . 14. *rufus*, sp. n.

29 (24). Two contiguous hypopleural spots; body elongate; abdomen with fused segments and very long cylindrical ovipositor; middle scapular bristles not distinct; wings with a yellowish fore border and a grey apical spot. 15. *longistylus*, Wied.

30 (23). Wings with a distinct anal brown stripe.

31 (34). A single hypopleural spot.

32 (33). Fourth longitudinal vein straight; only a brown cloud at the end of the anal vein. . . . . 16. *brevis*, Coq.

33 (32). Fourth vein strongly bisinuous; a brown stripe on the anal vein. . . . 17. *brevistylus*, Bezzi.

34 (31). Two contiguous hypopleural spots.

35 (38). Last portion of the fourth longitudinal vein S-shaped, distinctly bent forwards before reaching the costa; apical spot surpassing the third vein; anal cell infuscated on the disc; species of greater size.

36 (37). The brown apical spot of the wings united with a brown fore border; middle scapular bristles rudimentary. . . . . 18. *vertebratus*, Bezzi.

37 (36). A grey apical spot separated from the yellowish fore border; middle scapulars strongly developed. . . . . 19. *marginalis*, var. n.

38 (35). Fourth longitudinal vein perfectly straight towards the end, only slightly bent at base; wings with a blackish stigma and with an isolated apical black spot, almost surpassing the third vein; anal cell wholly hyaline; no middle scapular bristles; species of smaller size, hardly surpassing 5 mm. . . . . . . 20. *ficicola*, sp. n.

Subgenus Tridacus, nov.

1. **Tridacus lounsburyi,** Coquillett, 1901; Froggatt, 1909; Silvestri, Boll. Lab. Zool., Portici, viii, 1913, p. 91, fig. xxv, and Div. Ent. Hawaii, Bull. 3, 1914, p. 91, pl. viii, fig. xxv.

A large and very distinct species, originally described from Cape Town and Wynberg, Cape Colony. I have seen the specimens collected by Prof. Silvestri at Kirstenbosch, Cape Colony. Enderlein (1911) records the species from Tanga, German East Africa, and even from Madagascar; but I think that the present species has probably been confused with others of the same group.

2. **Tridacus sphaeristicus,** Speiser, 1910, (fig. 4).

A male specimen of this fine species from British East Africa, Nairobi, 30.i.1914 (Capt. A. O. Luckman); this specimen was named *lounsburyi*, but is easily distinguished from that species by the characters given in the table. The species seems to be confined to East Africa, having been originally described from Kilimanjoro.

The previously unknown male is very like the female; the third abdominal segment is ciliated. The wing pattern is very like that of the preceding species, but is different in having the large rounded dark spot of a more intensive tinge, filling up the upper corner of the discal cell; in *lounsburyi* there is also a hyaline streak along the middle of the first posterior cell (see fig. 10 in Froggatt, 1909), which in *sphaeristicus* is fairly distinct.

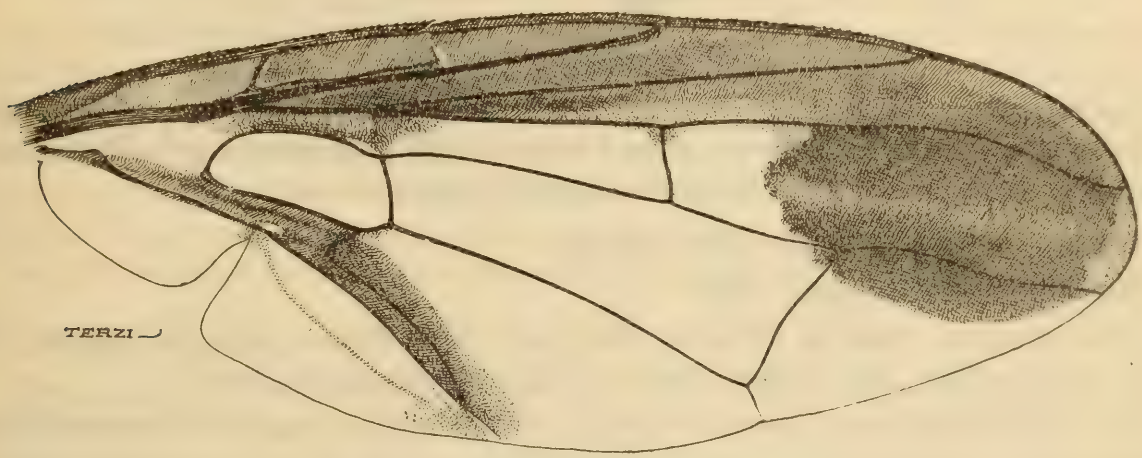

Fig. 4. *Dacus sphaeristicus*, Speiser.

A peculiar character of the species of the present group is to be found in the golden pubescence, which is very dense on the abdomen; the antennae are very long; the facial black spots are of triangular (not rounded) shape, with the vertex pointing inwards towards the mouth-edge. It seems from description that *D. fuscovittatus*, Graham, from Lagos, also belongs to this same group.

3. **Tridacus armatus,** Fabricius, 1805, (fig. 5).

A single female specimen from S. Nigeria, 3.iv.1914 (*Dr. W. A. Lamborn*) of what is undoubtedly the present species, recognisably described by Fabricius and Wiedemann. In Prof. Silvestri's paper I have misinterpreted it, as stated below.

The black facial spots are prolonged below into a point towards the mouth-edge; the frontal orbits are yellowish, with three dark spots on each side; the postsutural yellow stripes on the thorax are rather broad; humeral calli entirely yellow; mesopleural stripe broad, but not extended above along the suture; there is a yellow streak before the suture, in contact with the lateral curved stripes; hypopleural spots as in *vertebratus*. Ovipositor very long and pointed, and from this character is very probably derived the specific name. Hind femora entirely yellow; hind praetarsi ciliated below. Wings with very dark fore-band, filling two-thirds of the breadth of the first posterior cell; anal band very broad; last portion of fourth vein gently bisinuous.

Apart from *fuscatus*, Wied., there are four described species closely related to the present one, viz., *bivittatus*, Big., *pectoralis* Walk., *bipartitus*, Grah., and *cucumarius*, Sack; of these I think that the three last are only slight variations of a single species, which must be called *bivittatus*.

Fig. 5. *Dacus armatus*, F.

In Prof. Silvestri's paper (Portici 1913 and Honolulu 1914) I am responsible for the determination of the Trypaneids; what I have identified as *armatus* is *bivittatus*, and what is called *bipartitus* must be renamed *momordicae*, nom. nov.

4. **Tridacus bivittatus,** Bigot, 1858, (fig. 6).

Dacus bipartitus, Graham, 1909.

Dacus armatus, Bezzi in Silvestri, Boll. Lab. Zool., Portici, viii, 1913, p. 89, fig. xxiii, and Div. Ent. Hawaii, Bull. 3, 1914, p. 89, pl. viii, fig. xxiii.

This widely distributed species is easily distinguished owing to the humeral calli bearing only a small yellow dot on the fore corner and by the two contiguous hypopleural spots (fig. 6). The brown band on the fore border of the wing seems to be

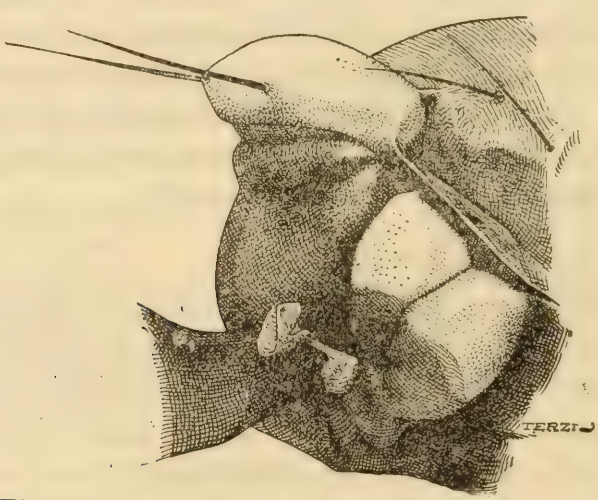

Fig. 6. *Dacus bivittatus*, Big.; an oblique posterior view of the thorax, to show the contiguous yellow hypopleural spots.

variable, usually filling only one-third of the breadth of the first posterior cell, but sometimes filling the whole cell, being extended to the fourth vein (var. *pectoralis*, Walker), only leaving hyaline the outer-angle. *D. cucumarius*, Sack, seems to be the same as *pectoralis*, for the figure of the wing given by its author is not correct, according to Dr. Speiser. The species is very destructive to cultivated Cucurbitaceae.

In the collection before me *bivittatus* is represented from the following localities :—Nigeria, Thadan (*Capt. Leslie*) ; Uganda Protectorate, Entebbe and Tero Forest, 9–16.viii.1911 (*C. C. Gowdey*), Mt. Kokanjero, S.W. of Elgon, 6,400 ft., 7–9.viii.1911 and Northern Buddu, 3,800 ft., 16–18.ix.1911 (*S. A. Neave*) ; Nyasaland, Muona, Ruo Distr., 12.x.1912 (*Dr. J. E. S. Old*) and Mt. Mlanje and Ruo, ix.–x.1913 (*S. A. Neave*).

A specimen from Kerinya, i.1911 (*Dr. G. D. H. Carpenter*), was sent to me determined as *bipartitus*, Graham ; and one of the specimens of Mt. Mlanje is determined as *pectoralis*, Walker, having probably been compared with the type.

5. **Tridacus momordicae,** nom. nov.

Dacus bipartitus, Bezzi (*nec* Graham) in Silvestri, Boll. Lab. Zool., Portici, viii, 1913, p. 90, fig. xxiv, and Div. Ent. Hawaii, Bull. 3, 1914, p. 90, pl. viii, fig. xxiv.

At present I have only seen the specimens bred from *Momordica* in Camerun by Prof. Silvestri, which I had erroneously referred to *bipartitus*. The species is very distinct owing to its single hypopleural spot ; the wing pattern is also characteristic, as shown in Prof. Silvestri's figure ; the mesopleural band is very broad ; the last portion of the fourth vein is strongly bisinuose. The unspotted frons is also characteristic. The facial black spots are large, and sometimes fused together, forming a single broad black band ; the latter condition seems to be the rule in the male sex.

6. **Tridacus eburneus,** sp. nov. (figs. 7, 8).

Closely allied to the preceding species, but readily distinguished by the coloration of the frons and thorax.

♂. Length of body, 7–8 mm. ; length of wing, 6–6·5 mm.

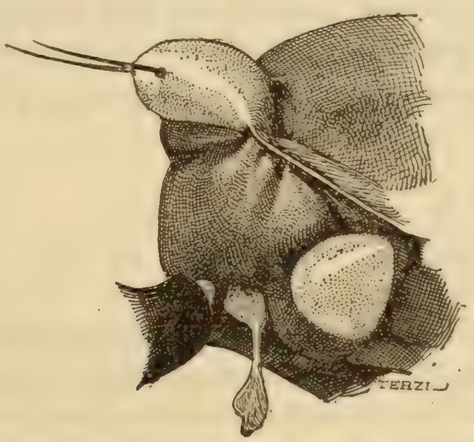

Fig. 7. *Dacus eburneus*, Bezzi, sp. n.; oblique posterior view of thorax, to show the single yellow hypopleural spot.

Prevailing colour of the body black, the ivory-coloured markings of the thorax very striking. Frons of a dark reddish brown colour, with less defined blackish markings, forming a transverse band, and some spots on the orbits, which are yellow ; occiput black, with a narrow yellow border ; face shining black, the jowls only being yellow ; the peristomial dark spots below the eye are broad ; palpi and proboscis dark yellow ; antennae long, dark yellow, the third joint infuscated towards

the end ; the bristles are all black ; three pairs of frontals, the basal one directed backwards, the two others forwards. Thorax black, punctate, with the following ivory-coloured markings :—The complete humeral callus ; two narrow arcuate stripes, one on each side of the dorsum, running from the suture to mid-way between the suture and scutellum ; a rather broad mesopleural band ; and a single rounded hypopleural spot (fig. 7). The thoracic bristles are black and there are four strong scapulars ; the anterior supra-alar is as strong as the others. Scutellum entirely ivory-coloured, only the extreme base black, with two long and strong black bristles. Halteres white. Abdomen black and punctate like the thorax ; hind border of the second segment

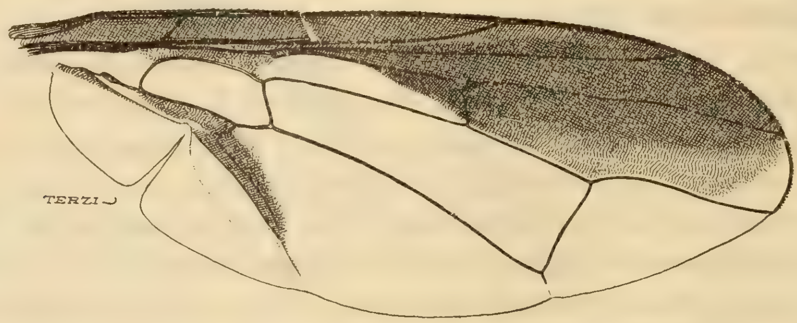

Fig. 8. *Dacus eburneus*, Bezzi, sp. n.

with a transverse entire yellow band, sometimes less distinct ; hind border of the third segment ciliated ; posterior middle part of fifth segment yellow. Venter dark brown. Legs yellow, the four anterior femora with a dark apical band ; front and hind tibiae black, the middle ones yellow, with dark base ; base of all the tarsi whitish. Wings with the fore band very dark and broad, extending without interruption to the fourth vein, but leaving clear the inferior angle of the first posterior cell ; terminal portion of fourth vein straight ; hind cross-vein short and straight ; anal band broad.

Type ♂ and an additional specimen from Uganda, Entebbe, 9.viii.1912 (*C. C Gowdey*).

7. **Tridacus xanthopterus,** sp. nov. (fig. 9).

A strikingly distinct species, which seems to have some affinities with the description of *scaber*, Loew, which, however, shows no anal brown stripe, but has an infuscated small cross-vein. The more striking peculiarities of the present species are the colour of the thorax, which is almost destitute of any yellow marking, except a very narrow mesopleural line, even the scutellum being of a brown colour, and the colour of the wings, which are suffused with a yellowish tinge on the disk. There is some affinity with the species of the first group (*lounsburyi*, etc.), as is shown also by the thin scapular bristles.

♀. Length of body, 9 mm. ; length of wing, 8·5 mm. ; breadth of wing, 3 mm.

Body of a uniform dark reddish brown colour, densely punctulate, and clothed on the disk of the abdomen and thorax with short yellowish pubescence. Face and frons of a more yellowish colour, occiput reddish, with a narrow yellowish border ; frons with three pairs of small black dots on the sides, a blackish central spot and a black ocellar transverse stripe ; lunula brown ; face unspotted, with only a narrow blackish line on the inner border of the antennal grooves ; peristomial black spot well

developed; palpi pale yellow, antennae with the two basal joints dark yellow, the third joint wanting. All the bristles of the head are black, and three pairs of orbital bristles are present. Thorax unicolorous, the humeral calli and the scutellum being only of a slightly lighter reddish colour; the very narrow yellow mesopleural stripe is placed along its distal border, extending only slightly on to sternopleura below and on to the sutural callus above; hypopleura unspotted; the bristles black, the anterior supra-alar well developed, the scapulars rudimentary, very thin, hardly discernible. Halteres whitish yellow. Abdomen almost spherical, of same colour and punctuation as thorax, without yellow markings; venter black; of the ovipositor

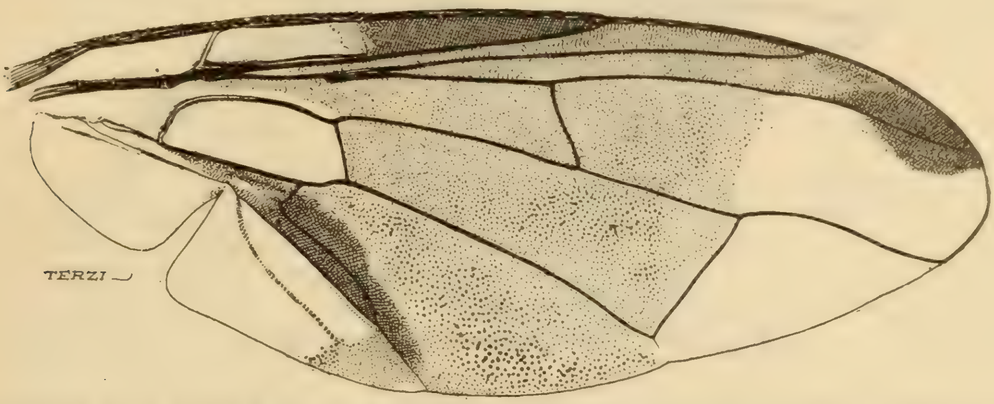

Fig. 9. *Dacus xanthopterus*, Bezzi, sp. n.

there is only the basal segment, which is black and very swollen. Legs of a uniform reddish colour, with white hairs and soft pubescence, only the basal joints of all the tarsi being white. Wings long and broad, with the last portion of fourth vein gently bisinuous; they are hyaline, but the middle part from basal to hind cross-vein and from costa to hind border, is suffused with a uniformly distributed yellowish tinge; the stigma honey-yellow; there are two brown markings, a small spot at the end of third vein and a broad streak on anal cell; the marginal and submarginal cells are not infuscated, only yellow, like the surrounding parts.

Type ♀, a single specimen from Nyasaland, Mt. Mlanje, 24.vi.1913 (*S. A. Neave*).

8. **Tridacus humeralis,** sp. nov. (fig. 10).

Apparently allied to the preceding species, but very distinct on account of the spotted face, the yellow spots on shoulders and hypopleura, and the different colour of the legs and wings.

♂. Length of body, 8·5–9 mm.; length of wing, 7–7·5 mm.; breadth of wing, 2·2–2·5 mm.

Body punctulate, of a blackish brown colour, with yellow markings, less pubescent than the preceding species. Head yellow; occiput reddish brown, bordered with yellow; frontal band with a rounded central dark spot and four black dots on each side, the last of which are placed on the vertex, where there is also a black dot; facial black spots of triangular shape, with the lower angle directed inwards to the mouth-edge; a blackish spot below the eye. Antennae long and geniculate, of a brownish red colour, but the third joint blackish; palpi reddish yellow; bristles black and strong, three pairs of orbitals. Thorax black on the disk, with three

more or less distinct longitudinal stripes and the sides reddish brown ; humeri reddish, with a less distinct yellow spot on the front corner ; behind the suture there are three yellow stripes, the middle one much abbreviated ; mesopleural stripe rather broad, not produced along the suture, but margined anteriorly with a broad black band, which shows whitish reflexions, the rest of the pleurae being of a reddish colour ; hypopleural spot rather small and margined with black ; mesophragma black, with a reddish longitudinal stripe. Scutellum yellow with black base ; halteres whitish. All the bristles are strong and black ; anterior supra-alar well developed ; the four scapular bristles very long and strong. Abdomen like the thorax, but the second

Fig. 10. *Dacus humeralis*, Bezzi, sp. n.

segment almost entirely reddish and the middle part of fourth and fifth more or less broadly reddish yellow ; venter greyish ; third segment with a row of black bristles extending from the venter half-way to the middle of the dorsum. Legs reddish brown, the bases of hind femora broadly and the bases of all the tarsi whitish. Wings hyaline ; the stigma and a narrow band filling the marginal and submarginal cells are yellow, becoming darker brown at the end of the submarginal, but not forming a definite spot ; small cross-vein lightly margined with yellowish ; anal brown band rather broad ; last portion of fourth vein distinctly bisinuous.

Type ♂ and an additional specimen of the same sex from Southern Nigeria, Oshogbo, xi.1910 (*Dr. T. F. G. Mayer*).

9. **Tridacus disjunctus,** sp. nov. (figs. 11, 12).

A very distinct species characterised by the two small and broadly separated hypopleural spots, in which perhaps it shows affinity with *flavicrus*, Graham, from Ashanti, but from which it differs in the leg coloration.

♀. Length of body, 8–8·5 mm. ; length of wing, 7–7·2 mm. ; breadth of wing, 2·5 mm.

Body blackish brown, punctulate, with sparse and short light yellow pubescence ; the yellow markings are well developed and very striking. Head yellow, but the occiput black, with a broad yellow border ; frontal band with a broad black spot in the middle, three pairs of orbital dots and a transverse stripe on the vertex ; facial black spots very small, not rounded, almost linear, placed obliquely and extended inwards to the mouth-edge ; palpi yellow ; antennae rather short, with the third joint entirely yellowish ; all the bristles black, three pairs of orbitals present. Thorax black, even on the pleurae, only slightly reddish on the sides behind the suture ; humeri yellow, but margined with black above and below ; three postsutural narrow

yellow stripes, the middle one very short; mesopleural stripe of medium size, not extended along the suture; two small hypopleural spots, the lower one being larger and separated from the other by a broad black area (fig. 11.); mesophragma black. Scutellum yellow, with black base. All the bristles are black, the scapulars very strong and the anterior supra-alar well developed. Halteres yellowish. Abdomen like the thorax, but the hind borders of the second and last segments are reddish yellow;

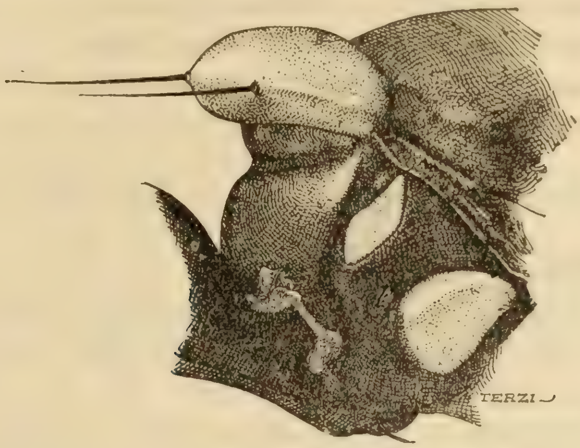

Fig. 11. *Dacus disjunctus*, Bezzi, sp. n.; oblique posterior view of thorax, to show the two hypopleural spots.

venter black; ovipositor very short, the basal joint tolerably swollen and reddish brown or blackish. Front and middle femora yellow with the apical half brown; hind femora entirely yellow; tibiae brownish black; tarsi yellow, a little darkened towards the end. Wings hyaline and with reduced pattern; there is a dark yellowish fore border not passing the third vein, and never reaching the apex, where there

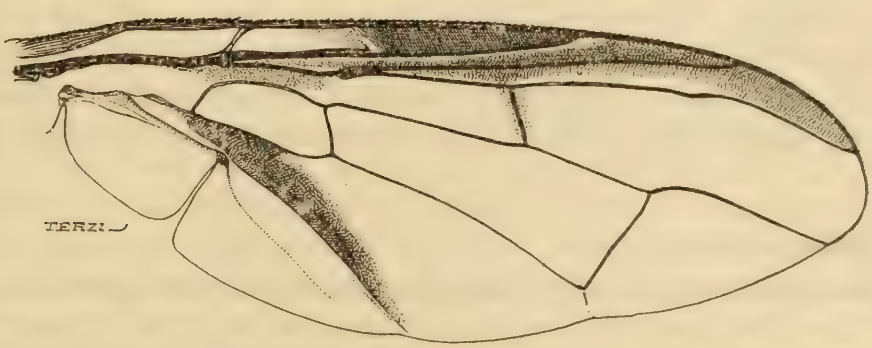

Fig. 12. *Dacus disjunctus*, Bezzi, sp. n.

is an indistinct dark spot; anal band rather broad at base, but not very dark; terminal portion of fourth vein bisinuous; stigma a little more intensively yellow; small cross-vein sometimes faintly margined with luteous.

Type ♀, and an additional specimen from Uganda, Entebbe, 17.viii.1911 (*C. C. Gowdey*).

10. **Tridacus punctatifrons,** Karsch, 1887.

This species, described originally from Loanda and recorded from Kilimanjaro by Dr. Speiser, is the smallest of its group, not surpassing 8 mm. in length; it is easily distinguished by the two contiguous hypopleural spots, the shaded small cross-vein and the blackish fore border of the wings; anterior supra-alar and scapular bristles long and strong. It shows a great resemblance to *Dacus vertebratus*, Bezzi. Third abdominal segment in the male ciliated; facial spots large and rounded.

There are in the collection some specimens from the Gold Coast, Aburi, xii.1913 (*W. H. Patterson*); from Uganda, Kerinya, Jinja, i.1911, on herbage (*Dr. G. D. H. Carpenter*); from Nyasaland, Mt. Mlanje, 31.xi.1913 (*S. A. Neave*); from Zanzibar, 1913 (*Dr. W. M. Aders*).

Subgenus, Dacus, s. str. (+ Leptoxyda).

11. **Dacus immaculatus,** Coquillett, 1901.

A very distinct species, the wing pattern of which has been figured in Froggatt's Report, 1909, pl. iii, fig. 9; it was originally described from East London, Cape Colony. The humeral calli are entirely yellow; the mesopleural stripe is broad and continued along the suture; the two hypopleural spots are of medium size and contiguous. Ovipositor very short, with the basal joint flattened.

A single female specimen from Natal, Estcourt, 19.ii.1913 (*R. C. Wroughton*).

12. **Dacus inornatus,** Bezzi, 1909.

I described this characteristic species in 1908 as *modestus* (not of Fabricius!) from Congo, Semlia Falls, N'Gami River; and subsequently I received a female specimen of it from the Belgian Congo, Kitobolu (*Dr. G. Rovere*).

The undescribed female is very like the male, but has the abdomen entirely black, without the narrow yellow border; the ovipositor is short, with the first joint swollen and of conical shape, entirely black. Face wholly shining black; frons shining black, with a dark brown band in the middle; occiput shining black; humeral calli entirely whitish; mesopleural stripe broad, but not continued to the suture; a single rounded hypopleural spot. The entire body is black, except the whitish markings on thorax and the scutellum; the wings are immaculate; the small cross-vein is lightly shaded with fuscous; the terminal portion of fourth vein almost straight.

13. **Dacus oleae,** Gmelin, 1788.

Of this Mediterranean species I have seen South African specimens collected in the Cape Colony by Lounsbury, and communicated by Prof. Silvestri and Prof. Berlese. They are identical with the Italian ones, as already stated by Prof. Silvestri in his Report, 1913, p. 85.

14. **Dacus rufus,** sp. nov.

A pretty species, characterised by the rufus coloration of the entire body, the yellow humeral calli, the single hypopleural spot, and the absence of the anal stripe on the wings.

♀. Length of body, 7 mm.; length of wing, 6·5 mm.; breadth of wing, 2·1 mm.

Head entirely rufous, without any dark spot on frons, orbits or occiput, only the ocellar dot blackish; face yellow, with two very striking, shining black, rounded spots; a less distinct dark spot below the eye; the swollen lower portion of the occiput yellow; antennae, palpi and proboscis entirely yellow; all the bristles black, three pairs of orbitals present. Thorax and pleurae entirely rufous, whitish on the back, with three less distinct longitudinal stripes; humeral calli yellow; a broad mesopleural stripe, continued above only to the sutural callus and below with a small spot on the sternopleura; a single rounded hypopleural spot. Scutellum yellow, with the extreme base rufous; mesophragma rufous; halteres whitish. All the bristles are black; the external scapulars are strong, but the internal are wanting. Abdomen rather elongate, not at all sphaeroidal, entirely rufous, with a faint trace of a middle dark stripe and of two spots on the sides of the third segment; venter yellowish; ovipositor short, red, the basal joint conical, swollen; middle segments partly fused. Legs entirely yellow, only the four posterior tibiae at base and the last tarsal joints a little darkened. Wings hyaline, with only the stigma, the marginal cell and a small border along the costa in the submarginal cell, dark brown; this border is dilated into a brown spot at the end of third vein; terminal portion of fourth vein straight.

Type ♀, a single specimen from N.W. Rhodesia, Chilanga, 19.ix.1913, on wild fig tree (*R. C. Wood*).

15. **Dacus longistylus,** Wiedemann, 1830.

The present species is the type of the genus *Leptoxyda*, because *L. testacea*, Macquart, of which I have seen specimens taken at Thies, Senegal, by Prof. Silvestri, is the same as Wiedemann's species; Surcouf has also figured the species from Senegal in *Insecta*, 1911, p. 269.

This species has entirely yellow humeral calli and two contiguous hypopleural spots; the middle scapular bristles are wanting; the abdominal segments are fused; the first segment of the ovipositor is very long, almost longer than the abdomen.

The species is always to be found on the plant *Calotropis procera*, like *Dacus kingi*, Froggatt (*Proc. of the Linn. Soc. of N.S. Wales*, xxxv, 1910, p. 866), from Khartoum, which has been bred from the fruits of the same plant and is undoubtedly a synonym. I have seen the species also from Kassala and from Erythraea (Keren and Sabarguma); the specimens from Assuan, Egypt, which I have received from Becker are almost one-half smaller than the others, but I cannot perceive other differences. The species occurs also in South India, probably imported from Africa.

16. **Dacus brevis,** Coquillett, 1901, (fig. 13).

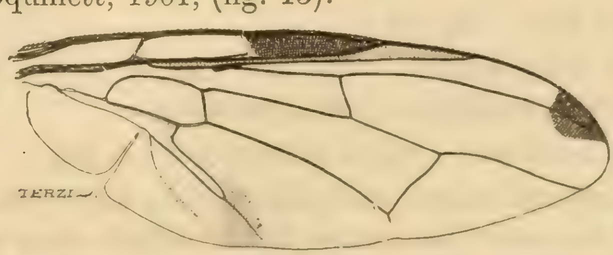

Fig. 13. *Dacus brevis*, Bezzi, Coq.

The present species has a wing pattern very like that of *immaculatus*, but there is a distinct rounded brown cloud from the end of the anal cell to the hind border; the facial black spots are well developed; humeral calli entirely yellow; a single but large and rounded hypopleural spot.

A single male specimen from Umbilo, Durban, 24.viii.1913 (*L. Bevis*); the species was originally described from Bathurst, Cape Colony.

17. **Dacus brevistylus,** Bezzi, 1908; Silvestri, Boll. Lab. Zool., Portici, viii, 1913, p. 94, fig. xxvii, and Div. Ent. Hawaii, Bull. 3, 1914, p. 94, pl. viii, fig. xxvii.

There is some doubt as to whether this species may not be the same as *D. sigmoides*, Coquillett (1901), from Mauritius. Humeral calli entirely yellow; a single rounded hypopleural spot.

The species is common in the Ethiopian region, and has been imported also into South India, living in melons and other cultivated Cucurbitaceae. It was originally described from Erythraea, and has since been recorded from Dahomey, Transvaal and Cape Colony; I have also specimens from German South West Africa, Windhoek, and from the Sudan.

In the collection before me it is represented from the following localities:—British East Africa, Nakuru, i.1913 (*Dr. B. L. van Someren*); Uganda (*C. C. Gowdey*); Nyasaland, Mt. Mlanje, 19.v.1913 (*S. A. Neave*); N. W. Rhodesia, Demere River near Chilanga, 2,000 ft., very plentiful on Citrus fruit tree, 27.v.1913 (*R. C. Wood*); Zanzibar, 1913 (*Dr. W. M. Aders*); Pretoria, 30.i.1914 (*David Gunn*); Durban, Umbilo, 24.v.1914 (*L. Bevis*).

18. **Dacus vertebratus,** Bezzi, 1908; Silvestri, Bull. Lab. Zool., Portici, viii, 1913, p. 93, fig. xxvi, and Div. Ent. Hawaii, Bull. 3, 1914, p. 93, pl. viii, fig. xxvi.

Described by me originally from Erythraea and subsequently recorded from Kilimanjaro, French Guinea and Southern Nigeria; I have also specimens from Senegal. The species is injurious to cultivated Cucurbitaceae. In the collection there are specimens from Nyasaland, Mt. Mlanje, 23.v.1913 (*S. A. Neave*); S. Nigeria, Ikotekpene, 17.v.1910 (*J. J. Simpson*); Pretoria, ii–iii.1914 (*David Gunn*).

19. **Dacus vertebratus** var. **marginalis,** nov.

Distinguishable from the type only by the brown apical spot being isolated from the fore border, on account of this border being yellowish, not brown. The character of the scapular bristles given in the table seems to be variable.

Several male specimens from Natal, Estcourt, 17.iii.1913 (*R. C. Wroughton*); N.W. Rhodesia, Mayabuku, 3,400 ft., in house, 7.xii.1913 (*R. C. Wood*).

20. **Dacus ficicola,** sp. nov. (fig. 14.)

This species has a wing pattern very like that of *brevis*, but may readily be distinguished by its two contiguous hypopleural spots.

♂. Length of body, 5–5·6 mm.; length of wing, 4·9–5·2 mm.

Frontal band of a dark red colour, with yellow orbits which bear three pairs of black spots; the lunula and an ocellar dot are also black; occiput dark brown, with a narrow yellow border, which is dilated below; face yellow, its two black spots shining and of

oval shape ; antennae light yellow, with the third joint darkened at the end ; palpi and proboscis reddish yellow ; bristles black, three pairs of orbitals. Thorax dark brown, black behind the suture and on the pleurae, with the following yellow markings : humeral calli entirely ; a rather broad mesopleural stripe, continued above along the suture to the dorso-central line, and below in a very small spot on the sternopleurae ; two rounded and contiguous hypopleural spots of medium size ; the whole scutellum except the base. Halteres whitish ; mesophragma black. Abdomen red, with a middle longitudinal black stripe and black spots on the sides of the segments ; the second segment also having a less distinct yellowish hind border ; dark spots of fifth

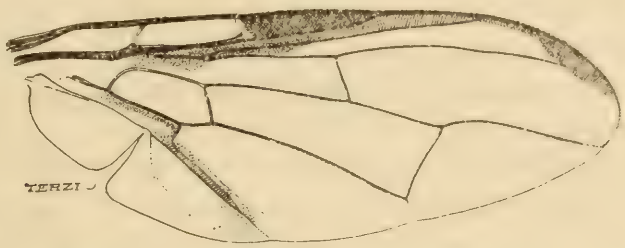

Fig. 14. *Dacus ficicola*, Bezzi, sp. n.

segment sometimes wanting ; third segment ciliated ; venter reddish. All the thoracic bristles are black ; only the external pair of scapulars is distinct. Legs reddish, the base of posterior femora, the end of tibiae, and the base of tarsi broadly whitish yellow. Wings narrow and long, hyaline, with the stigma, a spot on the end of third vein and an anal streak, brown ; marginal cell darkened, but there is no distinct dark border in the submarginal cell, or only a very narrow one, the apical spot being therefore almost isolated ; terminal portion of fourth vein straight.

Type ♂ from Natal, Willow Grange, 17.iii.1913 (*R. C. Wroughton*), and an additional specimen of the same sex from N.W. Rhodesia, Chilanga, 19.ix.1913, on wild fig tree (*R. C. Wood*).

AFRICAN APHIDIDAE.—Part II.*

By Fred. V. Theobald, M.A.

The following notes and descriptions of African plant-lice are based mainly on part of the large collection I have received from Mr. F. C. Willcocks, made in Egypt since 1907; specimens from Mr. Gerald Bedford, collected in the Transvaal and the Cape; and a small collection of spirit specimens without any colour notes sent to the Imperial Bureau of Entomology by Mr. T. J. Anderson from Nairobi, British East Africa. The collection made by Mr. Willcocks in recent years contains some hundreds of specimens, many in alcohol and many beautifully mounted, with field notes giving the living colours of most of the species. This very valuable collection seems to be almost complete for Egypt, for in a recent letter Mr. Willcocks tells me he is unable to find any new species. It contains a number of new insects and some well-known European and American species, including the corn pest, *Aphis maidis*, Fitch; the green pea louse, *Macrosiphum pisi*, Kalt.; *Macrosiphum sonchi*, L.; the so-called yellow clover aphis of America, *Callipterus trifolii*, Monell, which is here shown to be the *Aphis* (*Callipterus*) *ononidis* of Kaltenbach; the water-plant aphid of Europe and America, *Siphocoryne* (*Aphis*) *nymphaeae*, L.; and the European willow aphid, *Lachnus viminalis*, Boyer. The bean-root aphid, *Tychea phaseoli*, Pass., was also sent and the alate female is now described, as well as the first alate female of *Rhizobius*, apparently referable to Buckton's *Rhizobius graminis*. A large number of specimens in Mr. Willcocks' collection yet remain to be examined, including species from *Zizyphus*, *Duranta*, artichokes and sycamore figs; also others from Nairobi and some tubes of specimens sent by Dr. Aders from Zanzibar to the Imperial Bureau.

It may be once more pointed out that many specimens sent in spirit with no colour notes are almost impossible to identify with any degree of certainty. Colour is one of the main things in identifying these insects from old descriptions. Until definite structural characters are given we may have to rely on these. At present comparatively little is known of plant-lice in Europe and America, the only parts of the world in which they have been at all studied or even collected. With increasing information it appears that many species have a world-wide distribution, as for instance *Callipterus ononidis*, Kalt., which seems to be common to America, India, Europe and Egypt. Owing to the somewhat crude descriptions of many of the older species and the lack of any real structural characters, it is extremely difficult to say if any particular aphid coming from any part of the world is the same or distinct from one coming from elsewhere. Colour alone is of no value, it may cause considerable confusion in identifying these insects, so far as the original descriptions go. One instance will explain this. A wheat aphid sent by Mr. Willcocks from Egypt is undoubtedly *Toxoptera graminum*, but the colour notes he sends of this insect do *not* agree with those of this corn pest of Europe and America. On the other hand the aphid described

* For Part I. see Bull. Ent. Res., iv., p. 313.

here as *Siphocoryne splendens* might at first be mistaken for *S. avenae*, but its brilliant colours at once separate it, and then one can also detect some small, but marked, structural peculiarities.

I have been forced to add three new genera here, because they cannot be reasonably placed in any of the great number of genera which have been recently created, nor do they conform to the more natural genera of the older naturalists. One, which I call *Neotoxoptera*, because it comes near *Toxoptera*, is found on violets in the Transvaal; another, of most marked facies—*Saltusaphis*, the jumping aphid—is from sedges in Egypt; the third is a pine lachnid from the same country, for which I propose the name *Protolachnus*. Thirty-three species are here added to the scanty African fauna.

Second List of African Aphididae.

Macrosiphum pisi, Kalt.
Macrosiphum sonchi, L.
Macrosiphum compositae, sp. nov.
Macrosiphum nigrinectaria, sp. nov.
Macrosiphum hederae, sp. nov.
Macrosiphum rosaefolium, sp. nov.
Macrosiphoniella chrysanthemi, Del G.
Rhopalosiphum carduellinum, sp. nov.
Rhopalosiphum lactucellum, sp. nov.
Siphocoryne (? *Aphis*) *splendens*, sp. nov.
Siphocoryne (? *Aphis*) *nymphaeae*, L.
Aphis hederella, sp. nov.
Aphis pseudocardui, sp. nov.
Aphis leguminosae, sp. nov.
Aphis compositae, sp. nov.
Aphis punicella, sp. nov.
Aphis parvus, sp. nov.
Aphis maidis, Fitch.
Aphis laburni, Kalt.
Aphis medicaginis, Koch.
Aphis (?) *cynarae*, sp. nov.
Myzus tetrahodus, Walk.
Myzus asclepiadis, Pass.
Neotoxoptera violae, gen. et sp. nov.
Chaitophorus populus, L.
Callipterus ononidis, Kalt.
Saltusaphis scirpus, gen. et sp. nov.
Anoecia willcocksi, sp. nov.
Lachnus viminalis, Boyer.
Protolachnus tuberculostemmata, gen. et sp. nov.
Pemphigus globulosus, sp. nov.
Tychea phaseoli, Pass.
Rhizobius graminis, Buckton ?

Macrosiphum pisi, Kalt.

Aphis pisi, Kalt.
Siphonophora pisi, Koch, Buckton, etc.
Nectarophora destructor, Johnson.
Aphis pisum, Harris.
Nectarophora pisi, Sanderson.
Aphis lathyri, Mosley, Walker.
Aphis onobrychus, Boyer.
Acyrthosiphon pisi pisi, Mordw.

Kaltenbach, Mono. Pflanz., p. 23 (1843) ; Koch, Die Pflanz., p. 190, pl. xxxv, figs. 261–262 (1857) ; Buckton, Mono. Brit. Aph. i, p. 134, pl. xiv (1875) ; Mosley, Gard. Chron. i, p. 684 ; Walker, Ann. Mag. Nat. Hist. (2) ii, p. 421 (1848) ; Walker, Zoologist, vii, App. liii (1849) ; Walker, Cat. Homopt. B.M., iv, p. 966 (1852) ; Harris, Exposit. Engl. Ins., p. 66, pl. 17, figs. 10–12 ; Boyer de Fonscolombe, Ann. Soc. Ent. France, x, p. 169 (1841) ; Theobald, Journ. Eco. Biol., viii, p. 134, fig. 43 (1913) ; Mordwilko, Faune Russie Ins. Hemipt. i, p. 83 (1914).

Egypt : Gizeh and Ghezireh (*F. C. Willcocks*). British East Africa : Nairobi (*T. J. Anderson*).—Europe generally and North America.

Food-plants.—Broad beans, iv.08, iii.09, v.09, Egypt ; berseem and *Medicago* sp., iv.09, Egypt ; sweet peas, Nairobi. On all culinary and ornamental peas (*Pisum*), wild everlasting pea (*Lathyrus sylvestris*), red clover (*Trifolium pratense*), white clover (*T. repens*), alsike clover (*T. hybridum*) and shepherd's purse (*Capsella bursa-pastoris*), in Europe and America.

Numerous alate and apterous females of this aphid in Mr. Willcocks' collection and specimens sent by Mr. T. J. Anderson agree exactly with the European green pea louse. This insect, which is destructive in Europe to cultivated peas and beans, and still more so to peas in North America, seems to be very abundant in Egypt, especially on berseem.

Macrosiphum sonchi, Linnaeus.

Aphis sonchi, L.
Siphonophora achilleae, Koch.
Siphonophora sonchi, Passerini, Buckton.
Siphonophora lactucae, Koch (*non* Fabricius).
Aphis serratulus, L. ?
Siphonophora alliariae, Koch ?

Linnaeus, Syst. Nat. ii, p. 735 (1767) ; Fabricius, Sp. Ins. ii, p. 390 (1781), Ent. Syst. iv, p. 220 (1794), Syst. Rhyng., p. 302 (1803), and Mant. Ins. ii, p. 317 (1807) ; Schrank, Fn. Boica, ii, 1, p. 120 (1801) ; Rossi, Fn. Etrusc., p. 265 (1790) ; Kaltenbach, Mono. Pflanz. i, p. 28 (1843) ; Walker, Ann. Nat. Hist. (2) ii, p. 197 (1849), and Zool. vi, pp. 2246–2248 (part), (1848) ; Koch, Die Pflanz., p. 160, figs. 217–219 (1857) (*alliariae ?*) ; Koch, *ibid.*, p. 159, figs. 215, 216 (1857) (*achilleae*) ; Buckton, Mono. Brit. Aph. i, p. 161, pl. xxviii (1875) ; Theobald, Journ. Eco. Biol. viii, p. 64, fig. 6 (1913).

Egypt : Ghezireh, 20.iv.08 (*F. C. Willcocks*).

Food-plants. Thistles (*Carduus* sp.).

Alate and apterous females taken by Mr. Willcocks agree in all characters with the common European *Macrosiphum sonchi*, which has been found on the following plants in Europe :—*Sonchus oleraceus, Centaurea nigra* and cultivated varieties, *Serratula arvensis, Chrysanthemum segetum* and cultivated Chrysanthemums ; *Lapsana communis, Picris hieracioides, Crepis biennis, Hieracium sylvestre, Lactuca* and various *Carduus.*

Macrosiphum compositae, sp. nov. (fig. 1).

Apterous viviparous female.—Black ; tawny to some extent at the sides in a few specimens ; base of femora and most of the tibiae reddish brown. Antennae black, longer than the body, but not quite reaching to the tip of the cauda ; first segment much larger than the second ; the third long, with 80–90 sensoria scattered over its whole length, but scanty at the apex ; fourth and fifth segments equal in length, shorter than the third ; the sixth as long as four and five, its basal area about one-fourth the length of the fifth segment, the fourth and fifth imbricated and with the usual sensoria ; hairs on the third faintly capitate. Two median capitate hairs in front on the head and three on the prominent frontal lobes. Eyes large and black. Abdomen with slightly capitate hairs. Cornicles black, very long, in many cases

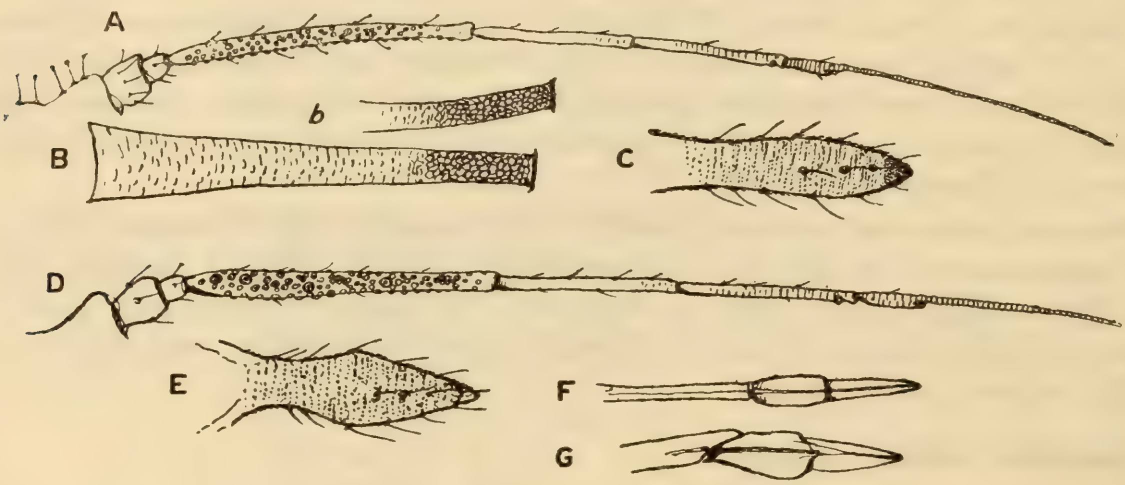

Fig. 1. *Macrosiphum compositae*, sp. n, ; A, antenna of apterous ♀; B, *b*, cornicles ; C, cauda. D, antenna of alate, ♀; E, cauda; F, proboscis of apterous ♀; G, proboscis of alate ♀.

quite half as long as the body, slightly expanding basally, and projecting well beyond the cauda, the apical area reticulate, the rest markedly imbricated, in some specimens they are straight, in others they are curved outwards. Cauda black, prominent, from about one-fifth to one-fourth the length of the cornicles, bluntly pointed and spinose, with six pairs of lateral hairs and three median dorsal ones. Anal plate black, with some prominent hairs. Legs long, especially the tibiae of the hind legs ; femora black, except at the base ; tibiae pale with black apex ; tarsi black ; femora and tibiae with short, stiff bristle-like hairs, especially numerous on the latter. *Length*, 3 mm.

Alate viviparous female.—Antennae longer than the body ; black ; basal segment very much larger than the second ; the third longer than the fourth with 90–100 sensoria scattered over its whole length, some much smaller than others, the small

ones to some extent being in groups. Cornicles thicker than in the apterous female, black and similarly ornamented. The proboscis reaches past the base of the second pair of legs, the apical segment as long as the penultimate. *Length,* 2·8 mm. ; wing expanse, 7·5 mm.

British East Africa : Nairobi (*T. J. Anderson*).

Food-plants. Compositae and a native plant called " Mocatha."

Described from a number of ♀♀, all of which were apterous but one, and this was damaged. It is evidently a black species, judging from the spirit specimens sent to the Bureau, which show tawny coloration at the sides of the body. The long jet-black cornicles vary somewhat in length and appearance, most being straight, but some are curved outwards at the tips. I know of no species like it in Europe or America. In alcohol it gave a deep claret stain. Its thick integument made it necessary to boil the specimens in caustic soda for nearly an hour before they could be cleared.

The species of Compositae upon which they were found was not mentioned.

Macrosiphum nigrinectaria, sp. nov. (fig. 2).

Alate viviparous female.—Apparently green, darker in the middle of the abdomen, with three dark pairs of lateral spots. Head light brown. Prothoracic lobes dark. Antennae longer than the body, two basal segments paler than the rest, which are dark

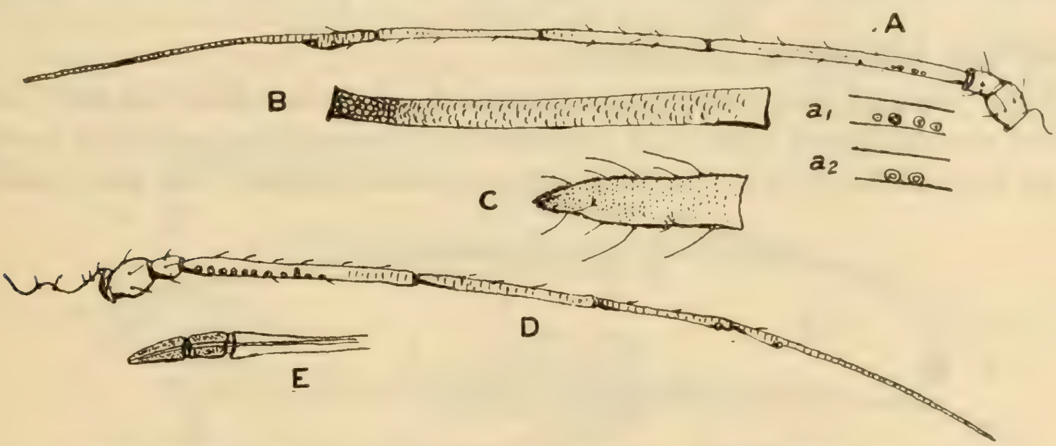

Fig. 2. *Macrosiphum nigrinectaria,* sp. n. ; A, antenna of apterous, ♀ ; a_1, a_2, variations in the sensoria ; B, cornicle ; C, cauda. D, antenna of alate ♀ ; E, tip of proboscis.

brown ; the first larger than the second ; the third with a line of 11 to 13 sensoria on one side extending up to about one-third of its length from the apex ; fourth shorter than the third ; fifth shorter than the fourth ; sixth as long as four and five together ; the last three imbricated, and to some extent the apex of the third. Eyes large, black. Proboscis reaching nearly to the third pair of legs ; last two segments dark, nearly equal in length. Wings with yellowish brown veins and stigma. Legs rather long, pale ; apices of femora and tibiae and all the tarsi dusky. Cornicles long, cylindrical, black, reticulate at the apex, the rest imbricated ; either straight or slightly curved outwards, about one-fourth the length of the body, projecting just beyond the cauda. Cauda pale, long, nearly half the length of the cornicles, bluntly pointed and turned upwards, with three pairs of large lateral chaetae and some smaller ones. Anal plate pale. *Length,* 2–2·5 mm.

Apterous viviparous female.—Green, somewhat darker in the middle. Antennae long, thin, green, tips of the third, fourth and fifth segments dark brown to black, the sixth darker with a still darker band at the junction of the nail and base of the flagellum. The first segment is larger than the second; the third has two to four sensoria near the base; the fourth and fifth nearly equal; the sixth as long as the fourth and fifth. Cornicles black, nearly one-third the length of the body, cylindrical, slightly expanding at the base, in some turned outwards at the tips, but usually straight, apex reticulate, the rest imbricated, reaching beyond the cauda. Cauda pale, long, about half the length of the cornicles, with six prominent lateral hairs and some others. Proboscis reaching to the third pair of legs, pale, last two segments dark, and about equal in length. Legs with smaller dark apical areas than in the alate female. *Length*, 2–2·5 mm.

BRITISH EAST AFRICA: Nairobi (*T. J. Anderson*).

Food-plant.—Garden peas and a native pea.

Described from several alate and apterous females. The black cornicles and pale long cauda are very marked. No colour notes were sent, but some examples had more or less preserved their general hue. In the spirit specimens I noticed that a pale band runs across between the cornicles and turns forwards on each side, but I am not sure if this is natural. There are also traces of small dark lateral spots on the dorsum of the abdomen in both forms.

Macrosiphum hederae, sp. nov. (fig. 3).

Alate viviparous female.—Antennae thin and much longer than the body, arising from well-marked frontal lobes; first segment much broader than and rather more than twice as long as the second, the inner side somewhat serrated, with two small hairs

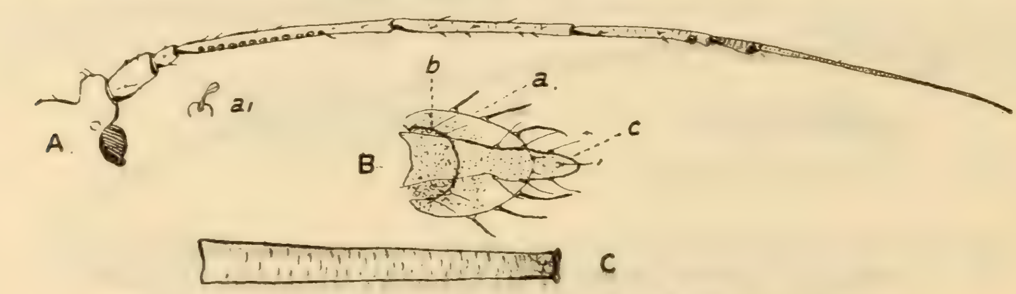

Fig. 3. *Macrosiphum hederae*, sp. n., alate ♀; A, antenna; a_1, antennal hair; B, *a*, sub-anal plate; B, *b*, anal plate; B, *c*, cauda; C, cornicle.

only; second segment small and barrel-shaped, with the usual hairs, both dark; third segment very dark, except just at the base where it is pallid, long, with 12 sensoria in a line on one side, not reaching to the apex; fourth a little shorter than the third and longer than the fifth, imbricated; sixth longer than the third, about as long as four and five, basal area about one-third the length of the fourth, with one large and several small sensoria in a group at its junction with the flagellum, imbricated; fourth and fifth paler than the third; sixth slightly darker than fourth and fifth; hairs short and blunt. Eyes large; stemmata marked. Proboscis reaching to near the base of the third pair of legs. Wings with normal venation; veins yellowish brown. Legs with dark coxae; the greater part of the femora dark, except just at the base;

tibiae pale with dark apex ; tarsi dark ; tibiae and apical area of the femora hirsute. Cornicles long, thin, cylindrical, slightly expanding basally ; pale, apex dusky and marked with a few reticulations, remainder imbricated. Cauda pale, not quite half the length of the cornicles, bluntly pointed, spinose, with three pairs of lateral hairs and one median dorsal subapical one ; anal plate dusky, with two pairs of lateral hairs, and beneath it a large dusky plate rounded on the posterior border, with three lateral pairs of long hairs, this plate not quite reaching to the end of the cauda. *Length*, 2·5 mm. ; wing expanse, 7 mm.

CAPE PROVINCE : Cape Town, 23.x.14 (*G. Bedford*).

Food Plant. Ivy (*Hedera helix*).

Described from a single perfect alate female found with *Aphis hederella*, sp. n. Its colours had gone in the spirit, but it appears to be of dark hue. It can however at once be distinguished by the marked posterior plate beneath the cauda and anal plate, a character which perhaps might place it in a new genus. I have never seen anything resembling it in the APHIDIDAE before. Type in the writer's collection.

Macrosiphum rosaefolium, sp. nov. (fig. 4).

? *Siphonophora rosaecola*, Passerini.

Alate viviparous female.—Green ; thoracic lobes dark ; antennae dark brown, paler in places. Cornicles green ; cauda green ; anal plate dusky. Legs green, with dark apices to the femora and tibiae and dark tarsi. Antennae as long as the body, arising from prominent frontal tubercles ; the basal segment larger than the second ; the third longer than the fourth and about as long as the sixth, with 17–20

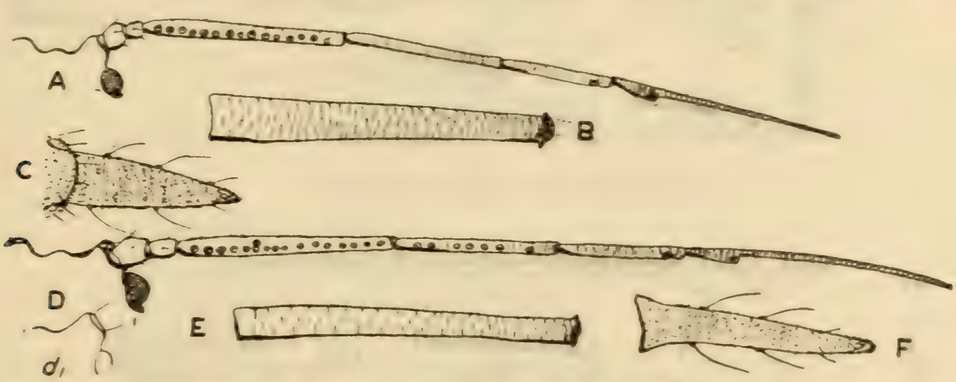

Fig. 4. *Macrosiphum rosaefolium*, sp. n. ; A, antenna of apterous ♀ ; B, cornicle ; C, cauda. D, head and antenna of alate ♀ ; d_1, head, showing larger frontal tubercle ; E, cornicle ; F, cauda.

sensoria, more or less in a line along its whole length ; fourth segment longer than the fifth, with 5–9 sensoria in a line ; sixth not quite as long as the fourth and fifth together, its basal area about one-fifth the length of the flagellum ; all the segments faintly imbricated ; the third to the sixth darkest, the former pale just at the base ; apices of the fourth and fifth slightly darkened ; hairs few, very short and blunt. Head slightly projecting in the median line in front, with a few short hairs, blunt in form. Eyes large and black. Proboscis scarcely reaching the second coxae, pale, its tip dusky. Cornicles green, dusky at the tips, long, thin, cylindrical, imbricated, with one or two striae at the apex ; not as long as the third antennal segment. Cauda long, narrow, lanceolate ; about two-thirds the length of the cornicles and projecting

well beyond them, with three pairs of lateral hairs, the apical pair short ; slightly spinose. Anal plate dusky, spinose ; beneath it the abdomen is black. Legs rather long and thin, femora pale at the base, dark apically ; tibiae pale, except at the apex, with numerous short spine-like hairs ; tarsi dark. Wings with yellowish brown stigma and veins, the latter darker than the stigma, the membrane slightly tinged with yellowish brown. *Length,* 2–2·3 mm.

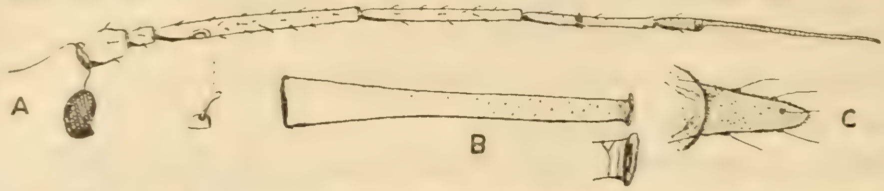

Fig. 5. *Macrosiphum rosaeollae,* sp. n., apterous ♀; A, head and antenna; B, cornicle; C, cauda.

Apterous viviparous female.—Green ; apices of the third to fifth antennal segments and all the sixth brown ; apices of the tibiae and the tarsi brown ; tips of the cornicles dusky. Eyes reddish. Antennae as long as the body, the basal segment larger than the second, arising from prominent frontal tubercles ; the third segment as long as or slightly longer than the sixth and much longer than the fourth, with a row of 15 to 18 sensoria in a line along its whole length, slightly darkened in this region and at the apex ; fourth segment a little longer than the fifth, both darkened

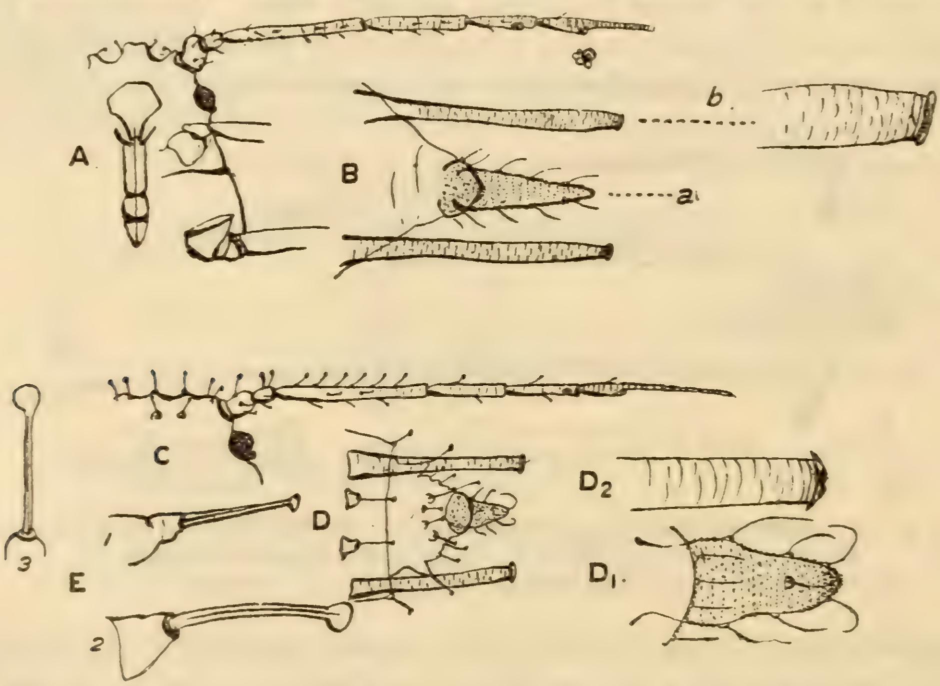

Fig. 6. *Myzus rosarum,* Kalt., apterous ♀; A, head and antenna; B *a,* cauda; B *b,* cornicles.
Myzus rosarum, Buckt., apterous ♀; C, head and antenna; D, cauda and cornicles; E, body hairs.

at the apex ; sixth a little shorter than the fourth and fifth, its basal area about one-fifth the length of the flagellum ; all the segments imbricated. Proboscis pale, darkened just at the apex, nearly or quite reaching the base of the second pair of legs. Cornicles green, dusky at the apex, long, thin, cylindrical, slightly expanded at the base and in a few specimens somewhat irregular in form, imbricated, with two striae at

the apex ; nearly as long as the third antennal segment. Cauda long, narrow, green, with three pairs of lateral bristles, the apical pair short ; about three-fourths the length of the cornicles. Legs moderately long, green, except for the apices of the tibiae and tarsi which are brown ; tibiae with short hairs, anal plate dusky. *Length*, 2–2·3 mm.

EGYPT : Ghezireh, Gizeh and Cairo, 20.iv.08, v.10, 12.iii.14 (*F. C. Willcocks*).

Food-plants. Roses.

Described from a series of apterous females and three alate females. It is a marked species, easily distinguished from any other rose *Macrosiphum* by the sensorial structure of the antennae in both forms of female and by the markedly short third pair of caudal hairs.

Another species of green *Macrosiphum* in Britain (*rosaeollae*) differs in having only 1 to 3 sensoria on the third antennal segment in the apterous female. From *M. rosae*, L., it can at once be recognised by the green cornicles.

It might be Passerini's *Siphonophora rosaecola*, but his description is equally applicable to the British species (*rosaeollae*).

Appended here is a list of the Aphides which occur on the rose from all parts of the world.

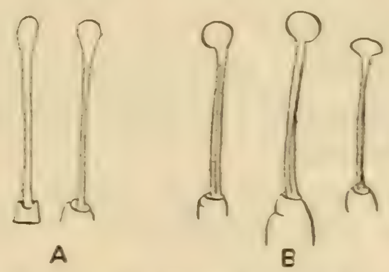

Fig. 7. Capitate hairs of:
A, *Myzus rosarum*, Kalt. ; B, *M. rosarum*, Buckton.

LIST OF ROSE APHIDES.

Macrosiphum rosae, L.
Macrosiphum rosaefolium, sp. nov.
Macrosiphum rosaeollae, sp. nov.
Macrosiphum rosaecola, Pass.
Macrosiphum solanifolii, Ashmead.
Macrosiphum rosaeformis, Das, sp. nov.
Myzus rosarum, Kalt.
Myzus neorosarum, nom. nov. (*rosarum*, Buckton).
Myzus tetrahodus, Walker.
Aphis dirhodum, Walker.
Hyalopterus trirhodus, Walker.
Hyalopterus dilineatus, Buckton.
Lachnus rosae, Mordwilko.

Of these I have not seen *Macrosiphum solanifolii*, a potato aphis recorded from *Rosa* by Miss Edith Patch in America, nor Mordwilko's *Lachnus rosae*. The species *Macrosiphum rosaeformis* was sent me from India by Mr. Das, with a note that probably Buckton's record of *Macrosiphum rosae*, L., from India was an error, as this species resembles *rosae* closely in appearance, but is very different in antennal ornamentation. He has sent me this Aphid, but I am waiting for him to describe it.

TABLE OF ROSE APHIDES.

I. Cornicles long.
- A. Frontal lobes large (*Macrosiphum*).
  - *a*. Cornicles black .. .. .. *rosae*, L.
  - *aa*. Cornicles green .. .. ..
    - *b*. Apterous ♀ antennae, third segment with many sensoria.. *rosaefolium*, sp. n.
    - *bb*. Apterous ♀ antennae, third segment with 3–5 sensoria .. *rosaeollae*, sp. n.
- B. Frontal tubercles very small.
  - *c*. Antennae moderately long (*Myzus*).
    - *d*. Capitate hairs on head, not on body.. .. .. .. *rosarum*, Kalt.
    - *dd*. Capitate hairs on head and body
      - Cornicles always green .. *neorosarum*, nov. nom.
      - Cornicles black in alate female .. .. .. *tetrahodus*, Walker.
  - *cc*. Antennae of apterae very short, only ¼ length of body (*Aphis*) .. *dirhodus*, Walker.

II. Cornicles short (*Hyalopterus*).
- *e*. Apterous ♀ green; alate ♀ green, with head, thoracic lobes and patch on body black .. .. .. *trirhodus*, Walker.
- *ee*. Apterous ♀ green with black markings; alate ♀ body all green .. .. *dilineatus*, Buckton.

III. Cornicles cone-shaped (*Lachnus*) .. .. *rosae*, Mord.

Macrosiphoniella chrysanthemi, Del Guercio (fig. 8).

Macrosiphoniella bedfordi, Theobald.

Del Guercio, Redia, vii, p. 332, fig. 30 (1911); Theobald, Bull. Ent. Res., iv, p. 318, fig. 4 (1914).

Alate viviparous female.—Deep red and black, abdomen deep red. Antennae slightly longer than the body, the two basal segments black, the first much larger than the second; the third long, nearly as long as the sixth, with 28 to 32 sensoria spread over the whole length, some large, and the lateral ones projecting, giving a marked tuberculate appearance; the fourth segment about as long as the fifth, with 6 to 7 sensoria; the sixth as long as the fourth and fifth together, its basal area about one-third the length of the fifth, flagellum long; last three segments imbricated; hairs simple. Cornicles thick and black, rather short, not so expanded basally as in the apterous female, most of the surface markedly reticulated, becoming at the base densely imbricated. Cauda black, as long as or slightly longer than the cornicles, with four pairs of long lateral hairs and two median dorsal ones. Anal plate black, spinose; wings tinged with brown and somewhat darkened along the veins. Legs with the base of the femora and most of the tibiae pale. Proboscis with the apex black, last two segments nearly equal. *Length*, 2·8–3 mm.

BRITISH EAST AFRICA : Nairobi (*T. J. Anderson*). TRANSVAAL : Onderstepoort, 6.iv.13 (*G. Bedford*). ENGLAND : Wye, Kent, 1.x.14 (*F. V. Theobald*) ; Little Hadham, Herts, 17.iii.15 (*F. V. Theobald*). ITALY (*Del Guercio*).

Food-plant. Chrysanthemums.

Since I have found this species in Europe and have compared it with the African specimens and have obtained alate females from Nairobi and Kent, I find that they agree so closely with Del Guercio's *M. chrysanthemi* that I have sunk *bedfordi* as a synonym of that species.

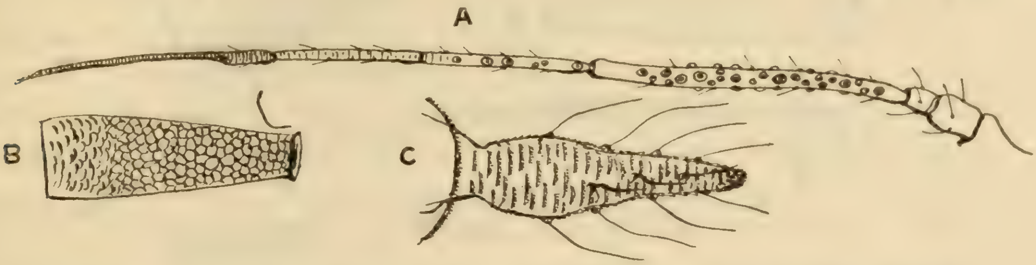

Fig. 8. *Macrosiphoniella chrysanthemi*, Del G., alate viviparous ♀; A, antenna; B, cornicle; C, cauda.

The apterae are a deep blackish-red to almost black and very shiny. The alatae are very sluggish. They cluster on the top shoots of cultivated chrysanthemums, both in the open and under glass, and do a considerable amount of damage, distorting and stunting the flower buds. In England they seem to occur from September to November in the open and right through the winter under glass.

Rhopalosiphum carduellinum, sp. nov. (figs. 9, 10).

Alate viviparous female.—Thorax and pleurae black. Abdomen green, with two pairs of elongated black spots in front, then a large dark area, four laterally elongate black spots on each side before the cornicles, the last the smallest, a small dark patch before the cauda, which with the anal plate is black. Antennae longer than the body, dark, the first segment a little longer and much wider than the second ; the third long, but not quite as long as the sixth, base paler, with 37 to 40 sensoria spread over the whole segment, some on each side projecting, giving a fine tuberculate appearance ; fourth segment about two-thirds the length of the third, with 20 to 25 sensoria over its whole length ; fifth a little shorter than fourth, with a line of six sensoria and two smaller basal ones ; sixth with the basal area less than one-fourth the length of the flagellum, all the segments imbricated, the flagellum markedly annulated, with a few short, scanty hairs. Proboscis with the last two segments dusky, reaching just past the second pair of legs. Legs moderately long, apical half of femora dark and a large dark area on the apex of the tibiae ; tarsi dark ; tibiae with fine, small hairs. Wings normal, with pale yellowish-brown veins and stigma. Cornicles black, thin, slightly swollen in the middle, more than half as long as the third antennal segment, apex with a few transverse lines, rest imbricated. Cauda prominent, bluntly pointed, nearly half the length of the cornicles, with three pairs of lateral hairs and one dorsal subapical one. Anal plate black and a marked black spot below it. *Length*, 2·5 mm.

Apterous viviparous female.—Pale green ; eyes red. Apices of the antennal segments and all the sixth brown. Tibiae, tarsi and the apex of the femora brownish ;

in some specimens the basal two-thirds of the tibiae are pale. Antennae longer than the body ; the first segment broader and a little longer than the second ; the third not quite as long as the sixth, with a line of 5 to 6 sensoria ; the fourth and fifth about equal, the latter with a normal subapical sensorium ; the sixth a little longer than fourth and fifth ; the third to the sixth imbricated, the flagellum of the latter annulated, with a few small hairs. Cornicles darker green than rest of body, slightly

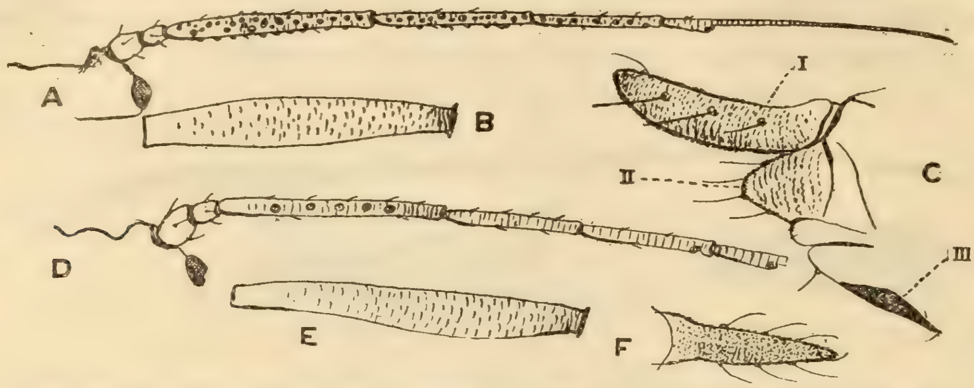

Fig. 9. *Rhopalosiphum carduellinum*, sp. n. ; A, antenna of alate ♀ ; B, cornicle ; C–I, cauda ; II, anal plate ; III, ventral spot. D, antenna of apterous ♀ ; E, cornicle ; F, cauda.

darkened at the tip, a little less than one-third the length of the body, slightly swollen on the apical half, a few transverse lines on the apex, the rest faintly imbricated. Cauda green, long and bluntly pointed, when exserted rather more than half the length of the cornicles ; three pairs of lateral hairs, one curved subapical, one dorsal and minutely spinose. Anal plate green. Proboscis short, not reaching the second pair of legs, broad and dusky at the apex. The tibiae bear minute hairs. *Length*, 2 mm.

Fig. 10. *Rhopalosiphum carduellinum*, sp. n. ; abdomen of alate ♀.

TRANSVAAL : Onderstepoort, 28.vii.14 (*G. Bedford*).

Food-plant. Thistles (*Carduus* sp.).

Described from two alate females and two apterous females, with many larvae and two nymphae. In the latter the cornicles are shorter and rather thicker than in the females and the wing-pads slightly darker than the rest of the body. I can find no species agreeing with this insect and I have seen nothing like it on thistles, except Walker's *Aphis carduinum*, which it certainly is not.

Types in the writer's collection.

Rhopalosiphum lactucellum, sp. nov. (figs. 11, 12).

Alate viviparous female.—Head shiny black; eyes very dark red. Antennae black; third segment pale at the base, as long as the body; first segment longer and wider than the second; the third nearly as long as the sixth, with 13–18 sensoria along its whole length, mainly on one side; fourth shorter than third and longer than the fifth; sixth about as long as four and five; fourth to sixth imbricated; a sub-apical sensorium on five and the usual group at base of the flagellum of the sixth (no sensoria on four as in *R. lactucae*). Pronotum greenish, with black collar, shiny; in some individuals the colour is obscure brownish-ochreous and the collar black; mesothorax with shiny black lobes, brownish at the sides and wing roots. Abdomen green, dark green to olivaceous green, with dusky or very dark olivaceous markings as shown in fig. 11. In some specimens the abdomen is obscure yellowish-green. Underside of thorax obscure ochreous brown, sternal plates shiny black; venter dull green. Cornicles dusky or dark olivaceous, median part distinctly paler in some, rather long, slightly swollen on the apical half, faintly imbricated. Cauda dusky to dark olivaceous, quite half as long as the cornicles, acuminate, spinose, with three pairs of lateral hairs. Anal plate dusky. Legs with basal half of femora pale or brownish, apical portion black; tibiae ochreous with black apices; tarsi black; tibiae hairy. Wings iridescent, insertions yellowish; cubitus yellowish; stigma smoky; costa and veins dusky. Proboscis about reaching the 2nd coxae, pale, with dusky apex. *Length*, 2 mm.

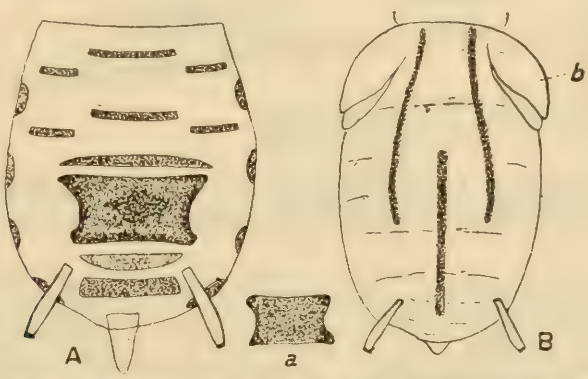

Fig. 11. *Rhopalosiphum lactucellum,* sp. n.; A, abdominal markings of alate ♀; *a,* median patch in some examples; B, abdomen of nymph; *b,* wing-pads.

Apterous viviparous female.—Pale yellowish-green to yellow tinged with green. Head pale yellowish-green. Eyes dark brown to black. Antennae about as long as the body; two basal segments of the same colour as head; third and fourth pale; fifth pale, but the apex smoky; sixth smoky on basal area, paler beyond; basal segment larger than second; third about as long as sixth; fourth shorter than third and longer than fifth; sixth about as long as four and five, its basal area about one-third the length of flagellum; fourth to sixth imbricated; a few hairs. Pronotum pale yellowish-green. Meso- and meta-notum and abdomen pale yellowish-green, of a slightly darker hue than head and pronotum; indications of a dorsal longitudinal line of a darker green colour and faint indications of a lateral line or more sub-median line of same colour. Apex of abdomen yellowish, tinged with green. Proboscis reaching the second coxae, tip black. Cornicles slightly swollen on apical half, colourless except at the tip where they are dusky, imbricated, the dark tip with well marked

striae, one very distinct. Cauda prominent, bluntly acuminate, about half as long as cornicles, pale, with three hairs on each side. Anal plate pale. Femora greenish to almost colourless; tibiae colourless, apices and tarsi brown. Venter pale yellowish green. Skin roughened, sometimes shiny. *Length,* 2 mm.

Nymph.—Green or pinkish; head pale yellowish-green; eyes very dark red, stemmata reddish. Antennae with the two basal segments of the same colour as the head; third and fourth colourless; fifth colourless, with smoky apex; sixth smoky. Pronotum pale green, tinged with yellow; mesonotum very pale yellowish-green; base of wing-buds very pale, apex pale ochreous or smoky. From the anterior margin of the mesonotum two prominent sub-median darkish green lines continue back to about the middle of the abdomen. Abdomen pale yellowish-green, a median darker green stripe of the same colour on the two submedian lines (fig. 11, B). Cornicles colourless, apex dusky. Femora pale greenish; tibiae colourless. In some individuals the head and thorax may be yellow and the stripes green, in others the head, thorax and abdomen are pink to salmon pink.

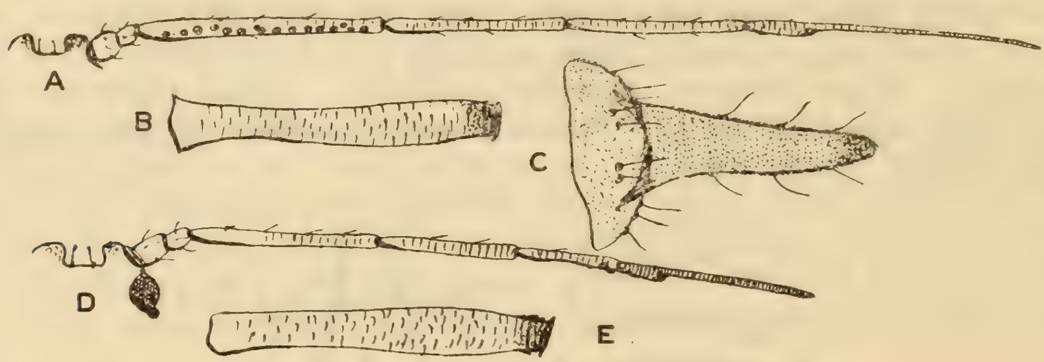

Fig. 12. *Rhopalosiphum lactucellum,* sp. n.; A, head and antenna of alate ♀; B, cornicle; C, cauda. D, head and antenna of apterous ♀; E, cornicle.

Larva.—Head yellowish green; eyes dark or very deep red. Antennae colourless, with the last segment smoky. Body pale green. Cornicles colourless, with dusky apical ring. Femora faintly greenish; tibiae colourless; tarsi dusky. Some larvae are all yellowish in colour, and others which are going to become nymphs are pink at a very early age. They also exhibit the three dorsal green lines at an early stage.

EGYPT: Gizeh, 11.iii.1910 (*F. C. Willcocks*).

Food-plants. Lettuce (*Lactuca*) and peach.

Described from several alate ♀♀, several apterae and nymphae. Colours noted by Mr. Willcocks from live specimens. This insect resembles at first sight *Rhopalosiphum lactucae,* but differs in the antennae and in the much thinner cornicles. Mr. Willcocks notes that in general appearance this lettuce aphis resembles one he found in the same locality on peaches, which are probably the alternate plant host.

Siphocoryne splendens, sp. nov. (fig. 13).

Apterous viviparous female.—Green and bright dark crimson. Head dusky olivaceous to obscure olivaceous orange; in some specimens slightly farinose; eyes black. Antennae smoky black, pale at the junction of the segments 3 and 4, and 4 and 5. Thorax dark olivaceous green or dark green. Abdomen, in front of cornicles

dull olivaceous green or obscure orange mottled with dull olivaceous green ; area between and surrounding base of cornicles crimson ; apex of abdomen pale olive-green, in all cases with a dusky band near the apical margin of the last segment. Cornicles, cauda and anal plate black. Under side green ; venter of abdomen sometimes obscure orange. Legs black ; in some specimens inclined to be olivaceous ; coxae smoky black. Proboscis greenish, with dark apex and base. Antennae much shorter than the body ; first segment much broader and slightly longer than the second ; third short, but about as long as the small fourth and fifth together ; the latter with a marked sub-apical sensorium ; the sixth as long as the third, fourth and fifth, basal area small, about two-thirds the length of the fifth, with a large sensorium ; the third with many long hairs ; the fourth and fifth with two or three long hairs, and one long one on each side of basal area of sixth ; whole of the sixth imbricated. Proboscis broad, reaching past the second pair of coxae. Body hairs few, scattered and simple. Cornicles a little longer than third antennal segment, rather broad, constricted at the apex, mouth flared, markedly imbricated. Legs rather short and thick, femora and tibiae with many rather long hairs. *Length*, 2–2·5 mm.

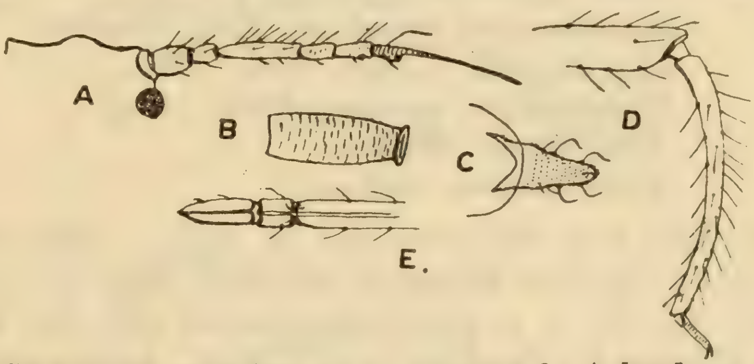

Fig. 13. *Siphocoryne splendens*, sp. n., apterous ♀ ; A, head and antenna ; B, cornicle ; C, cauda ; D, mid-leg ; E, apex of proboscis.

Alate viviparous female.—Description from field-note by F. C. Willcocks. " Head black, shiny. Eyes very deep blackish-brown. Antennae black. Prothorax dark olivaceous-green with shiny black collar. Thoracic lobes shiny black. Abdomen obscure olivaceous green, shiny. Cornicles brownish to dusky. Cauda of same colour as abdomen. Wings with yellowish green insertions ; stigma pale smoky ; cubital vein greenish ; costa and oblique veins dusky. Legs with black femora ; tibiae ochraceous with black points ; tarsi black.

" *Larva.*—Young. Orange, but of a darker or redder hue between the cornicles. Two slightly dusky areas on head, with pale orange lines between ; eyes black. Legs and antennae smoky. Cornicles dusky.

" Mature.—Head inclined to olivaceous, green at sides. Thorax and abdomen green, reddish between and around base of cornicles. Antennae and legs dark smoky. Cornicles dark. Some larvae have a general dull reddish hue.

" *Nymph.*—Head obscure orange to dusky tinged with orange ; eyes black ; antennae dull black. Thorax obscure orange, tinged with green or dull orange. Base of wing-buds pale greyish-green, apices smoky. Abdomen dull orange, reddish between and around base of cornicles. Cornicles black. Cauda black. Legs dull black ; first femora inclined to dull brownish."

EGYPT: Gizeh, 18.ii.08 (*F. C. Willcocks*).

Food-plant. Wheat.

Mr. Willcocks describes this species as "a very handsome green and crimson insect" inhabiting the lower part of the stems of wheat and the adventitious roots and also found on a spiky creeping grass, a common weed of agricultural land.

Its marked characters are the brilliant coloration, the presence of long hairs on the antennae and legs, and the shortness of the third to fifth antennal segments. In some respects it resembles Forbes' *Aphis maidisradicis*, but this species is all green and not the bright green and crimson of this one found in Egypt. Moreover, in comparing American specimens it is seen to be quite distinct.

I have not seen the alate female, so give Mr. Willcocks' notes on this form and also on the larva and nymph.

Siphocoryne nymphaeae, L.

Aphis nymphaeae, L.
Aphis plantarum aquaticum, F.
Rhopalosiphum nymphaeae, Koch, Passerini.
Rhopalosiphum alismae, Koch.
Rhopalosiphum najadum, Koch.
Aphis butomi, Schrank.
Aphis aquaticus, Jackson.

Linnaeus, Syst. Nat., ii, p. 714 (1767), and Fn. Suec., p. 983 (1789); Fabricius, Ent. Syst., iv, p 214 (1794), Syst. Rhyng., p. 297 (1803), Mant. Ins., ii, p. 315 (1807); Boyer, Ann. Soc. Ent. Fr., x, p. 166 (1841); Amyot, Ann. Soc. Ent. France, (2) v, p. 478 (1847); Schrank, Fn. Boica, ii, 1, p. 117 (1801); Kaltenbach, Mono. Pflanz., p. 104 (1843); Walker, Ann. Nat. Hist. (2) v, p. 26 (1850), List Homopt. B. M., iv, p. 984 (1852); Koch, Die Pflanz., p. 26, figs. 33–35 (1857); Passerini, Aphid. Ital., p. 21 (1863); Ferrari, Spec. Aphid. Liguriae, p. 217 (1872); Buckton, Mono. Brit. Aph., ii, p. 12, pl. xli (1877); Schouteden, Mém. Soc. Ent. Belg., xii, p. 236 (1892); Riley, Insect Life, v, p. 236 (1893); Osborn & Sirrine, Proc. Iowa Acad. Sci., i, 3, p. 98 (1892); Cowen, Bull. Agri. Exp. Sta. Colorado, Tech. Ser. 1, p. 123 (1895); Cockerell, Science, xxii, p. 764 (1905); Jackson, Ohio Nat., viii, p. 243 (1908); Davis, Ent. News, xxi, p. 245 (1910); Theobald, Entomologist, xliv, p. 18 (1911).

EGYPT: Gizeh, 5.vi.1914 (*F. C. Willcocks*).

Food-plant. Lotus Water Lily.

Mr. Willcocks found this common water-plant aphid on the upper sides of the leaves and on the leaf and flower stalks and flower buds of the lotus lily. It is common in Europe and America and occurs on *Nymphaea lutea*, *N. alba*, *Alisma plantago*, *Potamogeton natans*, *Sagittaria sagittifolia*, *Utricularia vulgaris*, *Butomus umbellatus*, *Fostederia cordata*, *Hydrocotyle vulgaris*, *Hydrocharis morsusranae*, *Lemna gibba*, *Pontederia*, *Azolla filiculoides*, *Marsilea quadrifolia*, *Salvinia natans*, *Ranunculus sceleratus*, *Typha latifolia*, *Sparganium ramosum*, *Acarus calamus*, *Saururus cernus* and *Menyanthes trifoliata* in Europe. In America also on *Philotria canadensis*, *Nymphaea odorata*, *Sagittaria variabilis*, *Najar flexilis*, *Elodea canadensis*, *Richardia africana*, *Juncus* sp., *Calla* sp., and *Myriophyllum verticillatum*.

Aphis hederella, sp. nov. (fig. 14).

Alate viviparous female.—Evidently a dark-coloured species, with paler abdomen. Antennae much shorter than the body ; the two basal segments dark ; the third dark, except the base ; apex of fourth and fifth dark and all the sixth ; the basal segment wider than, but of almost the same length as the second ; the third a little longer than the fourth, but shorter than the sixth, with a row of 6 round sensoria on one side, extending from near the base to the apex ; fourth and fifth equal ; the sixth as long as the fourth and fifth, its basal area not quite half the length of the flagellum ; the usual sensorium at the apex of the fifth and at the apex of the nail on the sixth ; segments all imbricated. Head flat in front ; eyes large ; stemmata, 3. Proboscis reaching past the second pair of legs. Wings ample, with brown veins and stigma. Cornicles rather short, black, expanded basally and with flared tips, about the length of the cauda, imbricated. Cauda black, spinose, with three long hairs on each side. Anal plate black. Legs pale, with dark apices to the tibiae, dark tarsi and traces of darkening on the apices of the femora ; a few hairs on the tibiae and apex of femora, one on the basal segment of the tarsi and one near the apex of the last segment, which is imbricated. *Length,* 1·5–1·8 mm.

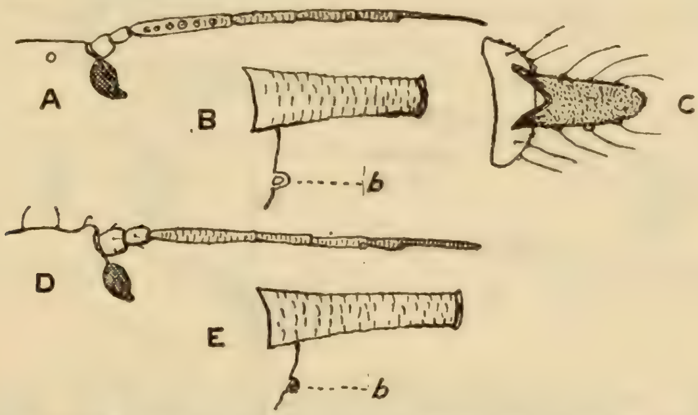

Fig. 14. *Aphis hederella,* sp. n.; A, antenna of alate ♀; B, cornicle; *b*, papilla between cornicle and cauda; C, cauda. D, antenna of apterous ♀; E, cornicle.

Apterous viviparous female.—Dark. Antennae shorter than the body, the two basal segments dark ; the third and fourth and base of the fifth pale, its apex and the sixth dark ; basal segment much wider than, but about the same length as, the second ; the third longer than the fourth, but not quite as long as the sixth ; fourth and fifth equal, the latter with a sub-apical sensorium ; the sixth with the basal area half as long as the flagellum, with the usual sensoria at their junction ; all the segments from the third imbricated. Head rounded in front, with a few hairs. Cornicles deep black, thick, slightly expanded basally, imbricated, longer than the cauda. Cauda and anal plate black, spinose, the former with three pairs of long lateral hairs. A distinct lateral tubercle on each side of the prothorax, a smaller one between the second and third pairs of legs and a dark one between the cornicles and cauda. Legs rather short and thick ; tibiae with hairs ; one on the basal tarsal segment and two on the last segment, which is imbricated. *Length,* 1–1·6 mm.

Cape Province : Cape Town, 23.x.13 (*G. Bedford*).

Food-plant. Ivy (*Hedera helix*).

Described from a number of alate and apterous females. No colour notes were sent, but from spirit specimens it seems to be a dark-coloured species. It is much smaller and more fragile than the European ivy aphis (*Aphis hederae*, Kalt.) and it does not colour alcohol deep reddish-brown as does that species. There were a number of nymphae also, very dark, with dark wing-pads and the hind tibiae with rather longer hairs than in the apterae or alatae.

Aphis hederae has many sensoria on segment 3 of the antennae and some also on 4 and 5 ; the head is not flat and the cornicles are longer. So far as I have traced, *Aphis hederae*, Kalt., may be the same as *Aphis* (*Myzus*) *lychnidis*, Kalt. At least I find that one can transfer *hederae* in spring to the Red Campion and that winged *lychnidis* will live on ivy.

Aphis pseudocardui, sp. nov. (fig. 15).

Apterous viviparous female.—Dark ; third segment of the antennae and most of the tibiae pale. Head slightly curved in front ; eyes large. Antennae not quite half the length of the body, the two basal segments black ; the basal one wider than the second, but of the same length ; the third about as long as the sixth, pale, sometimes slightly dusky at the apex, with 1–3 marked circular sensoria ; the fourth and

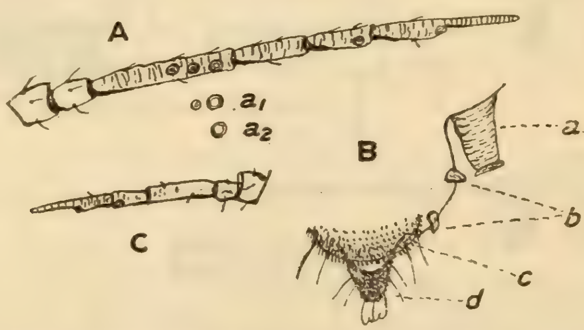

Fig. 15. *Aphis pseudocardui*, sp. n., apterous ♀; A, antenna; a_1, a_2, variations of sensoria; B, *a*, cornicle; B, *b*, *c*, lateral papillae; B, *d*, cauda ; C, antenna of larva.

fifth about equal, each about half the length of the third ; the fifth with a sub-apical sensorium ; the sixth with the basal area as long as or slightly longer than the blunt flagellum ; the last three segments dark ; all imbricated. Proboscis dusky at the apex, acuminate, reaching nearly or quite to the second coxae. Legs moderately long and thick ; the femora pale at the base ; the tibiae hairy, pale, except at the apex ; tarsi and ungues dark. Cornicles black, short and thick, a little more than half the length of the third antennal segment, expanding basally, imbricated. Cauda and anal plate black ; the former triangular, the apex blunt and rounded, spinose, with two pairs of lateral hairs and three at the apex bent at their tips ; anal plate very spinose, with a few long hairs. Abdomen with two marked lateral papillae between the cornicles and cauda, one between the mid and hind legs, near to the latter, and one on each side of the pronotum. *Length*, 1·5–2 mm.

Transvaal : Onderstepoort, 28.vii.14 (*G. Bedford*).

Food-plant. Thistles (*Carduus* sp.).

Described from several specimens sent in alcohol. It differs from *Aphis cardui*, F., in the much shorter and thicker cornicles. The two lateral tubercles between the

cornicles and cauda are very marked. The presence of sensoria on segment 3 of the antennae is also characteristic; they vary from one to three, the latter being the usual number. I know of no other related species showing this peculiarity.

Judging from the alcohol specimens sent, this insect is black to dark brown. It was found densely clustering on the thistle leaves in colonies, curling them up, and also encrusting the stalks.

Aphis leguminosae, sp. nov. (fig. 16).

Alate viviparous female.—Black; abdomen very dark brown or dull olivaceous, with black transverse median bars and lateral spots. Antennae shorter than the body, the two basal segments dark, third to fifth paler, the apex of fifth and sometimes the fourth darkened; sixth dark; basal segment larger than the second; the third a little longer than the fourth, with from 3 to 7 sensoria; the fifth of the same length as the fourth, sometimes slightly shorter, with a single sub-apical sensorium; sixth longer than the third and not quite as long as the fourth and fifth, its basal area about half the length of the flagellum, with the usual sensoria at their junction; all

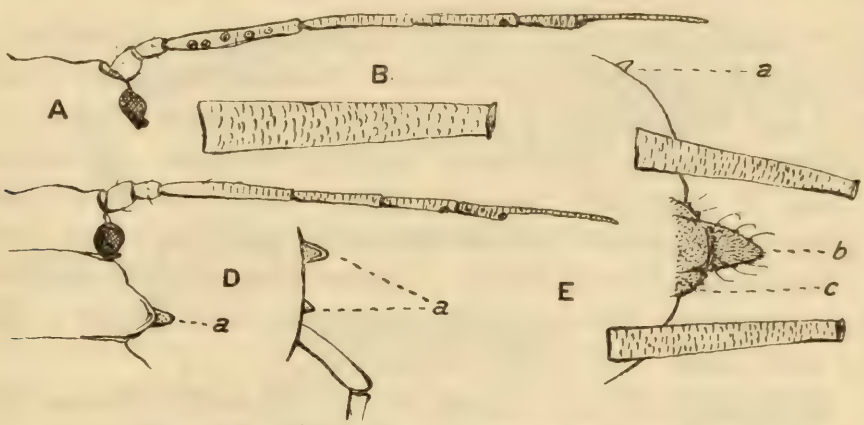

Fig. 16. *Aphis leguminosae*, sp. n.; A, head and antenna of alate ♀; B, cornicle. C, head and antenna of apterous ♀, (*a*) prothoracic tubercle; D, lateral abdominal tubercles between mid and hind legs; E, cauda and cornicles, (*a*) lateral abdominal tubercle, (*b*) cauda, (*c*) anal plate.

the segments imbricated. Eyes large. Proboscis dark at the apex, reaching to the second pair of legs. Prothorax dark greenish with black collar, and with a blunt papilla on each side. Abdomen with a large papilla on each side between the mid and hind legs and a smaller one between the cornicles and cauda. Cornicles black, rather long and cylindrical, markedly imbricated, but less so at the apex, reaching to or past the tip of the cauda, as long as or slightly longer than the third antennal segment. Cauda black, spinose, with three pairs of lateral hairs, curved at their apex, especially the apical pair, varying from one-third to more than one-half the length of the cornicles. Anal plate black, with two long hairs on each side of the cauda. Legs moderately long; femora dark, except at the base; tibiae pale, except at the apex, hairy; tarsi dark. Wings tinged with brown; stigma deep yellowish-brown to smoky, veins yellowish brown; cubitus ochreous; insertions yellowish to yellowish green. *Length*, 1·5–2 mm.; wing expanse, 8–8·5 mm.

Apterous viviparous female.—Dark olive-brown to black, with darker abdominal bars and spots; skin with marked reticulations, each having a central spot. Antennae

dark, except third to fifth segments, which are pallid yellow; base of femora and most of tibiae pale yellowish; rest dark. Head and prothorax narrower than rest of body; head rounded in front. Antennae shorter than body; basal segment larger than second; third longer than fourth, about as long as the sixth; fourth about as long as the fifth; the sixth with the basal area about half the length of the flagellum or a little more; all the segments faintly imbricated. Eyes large, black to dark brown, slightly separated from the base of the antennae. Proboscis dark at apex, reaching to second pair of legs. On each side of the pronotum is a prominent tubercle, and the abdomen has two lateral papillae between the mid and hind legs and a smaller one between the cornicles and cauda. Cornicles black, long, cylindrical, slightly expanding at the base, imbricated. Cauda black, spinose, with three pairs of lateral hairs, the apical pair prominently curved at the tips; from one-half to nearly one-third the length of the cornicles. Anal plate black, with two large hairs on each side. Legs with the femora black, except at the base, where they are yellow, tibiae hairy, yellow, except at the apex, which with the tarsi is black. *Length*, 1·8–2 mm.

Nymph.—" Obscure olivaceous, with two dusky areas, one on each side of the middle line. Head sparsely farinose. Eyes black. Antennal segments 1 and 2 olivaceous or smoky; 3 and 4 ochraceous; 5 ochraceous, with apex smoky; 6 black. Pronotum olivaceous, deeply compressed laterally, farinose. Mesothorax greenish, farinose; base of wing-buds greyish green, apices dusky or dark olivaceous. Abdomen olivaceous farinose, median line of a paler hue than general colour of abdomen. Cornicles and cauda black. In some specimens the abdomen is brownish between the cornicles. Femora dusky ochreous, apex dusky; tibiae ochreous, apex black; tarsi black."—F. C. W.

EGYPT: Ghezireh, 16.iv.02; Gizeh, vii.09; Mehellet, Mousa, 22.iii.10 (*F. C. Willcocks*). BRITISH EAST AFRICA: Nairobi (*T. J. Anderson*).

Described from a series of alate and apterous females sent me by Mr. F. Willcocks. At first sight this species resembles *Aphis rumicis*, L., but the alate female can at once be told from that species by the sensorial structure of the antennae. In this species one never finds sensoria except on segment 3, and they vary from 3 to 6; in *A. rumicis* there are many on the third segment and some on the fourth and fifth. The lateral papillae also seem to differ. The specimens from Egypt were all found on beans and cow-peas, but in Nairobi it occurs also on *Gleditschia triacanthos*, an ornamental leguminous tree from America. In some respects it resembles *Aphis tavaresi*, Del G., but can at once be told by the fewer sensoria on the third antennal segment and its paler colour. Also the cauda has only three pairs of lateral hairs, the last pair of which are markedly curved at their apex. The brown clouding of the wing membrane also gives it a resemblance to *Aphis compositae*, described below, but it can be easily separated by the cauda in *compositae* having 6–7 pairs of lateral hairs. Moreover, it gives in alcohol a brighter port wine stain than any of the other blackish aphides. I have placed the specimens (mostly broken debris) from East Africa here, because on mounting the remains I found they agree with the specimens sent from Egypt. They gave a similar coloration in alcohol. Mr. Willcocks in his careful field-notes adds that this species may have the thorax and abdomen in the apterous female slightly polished, and that the most conspicuous feature is in the skin, which

is covered with reticulation, each space having a central spot. This I have found very marked in the spirit specimens sent me and the same showed in the East African ones. Also it appears from Mr. Willcocks' notes that some apterous females have the black transverse bars, which occur on the apical segments, merging into a blackish dorsal median area. The younger females, he says, are olivaceous and sparsely covered with a farinose secretion, which overlays the dark colour and gives them a slaty grey appearance, just as in *Aphis rumicis* when on broad beans.

Aphis compositae, sp. nov. (fig. 17).

Alate viviparous female.—Head and thorax dark; abdomen paler (colour ?). Antennae shorter than the body, dark brown all over; first segment a little wider but no longer than the second; the third longer than the fourth, but not as long as the sixth, with 14–18 sensoria on one side, reaching to the apex of the segment; fourth slightly longer than the fifth, the latter with a sub-apical sensorium at a little distance from the tip; the sixth as long as the fourth and fifth, its basal area about one-third the length of the flagellum; a few hairs on all the segments, which are imbricate or

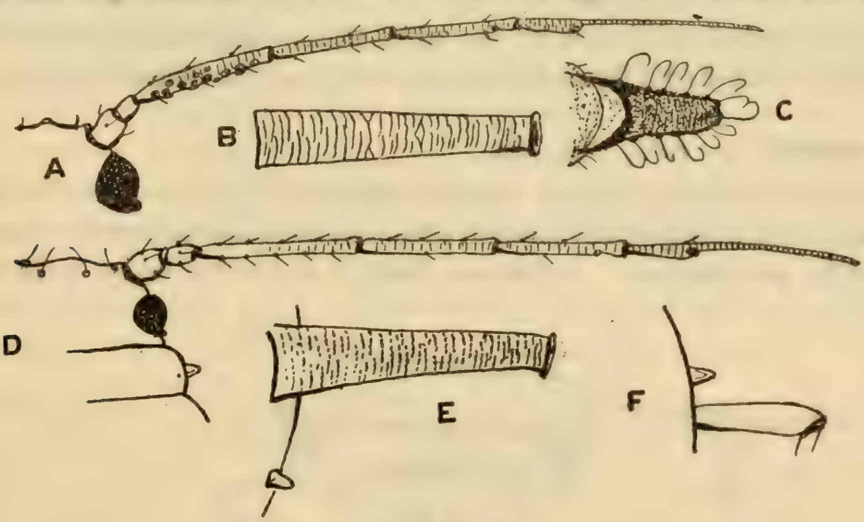

Fig. 17. *Aphis compositae*, sp. n.;
A, antenna of alate ♀; B, cornicle; C, cauda. D, antenna of apterous ♀; E, cornicle; F, lateral papilla on abdomen.

striate. Eyes large, black; stemmata distinct. Prothorax with a papilla on each side. Abdomen with dark transverse bars, large dark lateral spots, and a dark area at the base of the cornicles. Cornicles black, about as long as the third antennal segment, cylindrical, or slightly expanding at the base, strongly imbricated and with some complete striae, which may be forked or variously branched. Cauda black, spinose, with several lateral hairs, which are curved at their apices, about half the length of the cornicles; anal plate black and spinose. Legs pale, with the apices of the femora and tibiae and the tarsi dark; tibiae hirsute. Wings tinged with brown, veins and stigma yellowish brown. The abdomen has a prominent lateral papilla before the hind legs, is slightly raised at the sides and bears a few moderately long hairs. *Length*, 2 mm.

Apterous viviparous female.—Black; antennae pale in the middle; tibiae and bases of the tarsi pale. Antennae shorter than the body; the first two basal segments dark, the first wider and very slightly longer than the second; the third and fourth

pale ; fifth pale, except at the region of the sensorium and tip ; sixth dark, especially on the apical half of the basal area and tip of the flagellum ; third segment longer than the fourth and nearly as long as the sixth ; fourth a little longer than the fifth ; fifth with the sensorium at some little distance from the apex ; sixth with the basal area about one-third the length of the flagellum. Proboscis dark at the apex, reaching just past the second pair of legs. Pronotum with a lateral tubercle on each side. A prominent tubercle on each side of the abdomen just before the hind legs and another between the cornicles and cauda ; a few moderately long hairs. Cornicles black, imbricated, slightly expanding basally, about as long as the third antennal segment. Cauda black, similar to that of the alate female. Legs rather short and thick ; femora and tibiae with long pale hairs and two on the tarsi, which are imbricated. *Length,* 2–2·5 mm.

British East Africa : Nairobi (*T. J. Anderson*).

Food-plants. Compositae (species unknown).

Described from 2 alate and several apterous ♀♀ preserved in spirit. A somewhat obscure species resembling *Aphis rumicis*, but distinguished by the different antennal structure in the alate female and by the more striate ornamentation of the cornicles. For comparison with *Aphis leguminosae*, sp. nov., see the preceding species.

Aphis (?) **cynarae,** sp. nov. (fig. 18).

Alate viviparous female.—Head black ; prothorax pale ; thoracic lobes black ; abdomen pale, with a large dark median area and dark lateral spots ; cornicles short, brown ; cauda pale brown. Antennae shorter than the body, pale brown ; legs

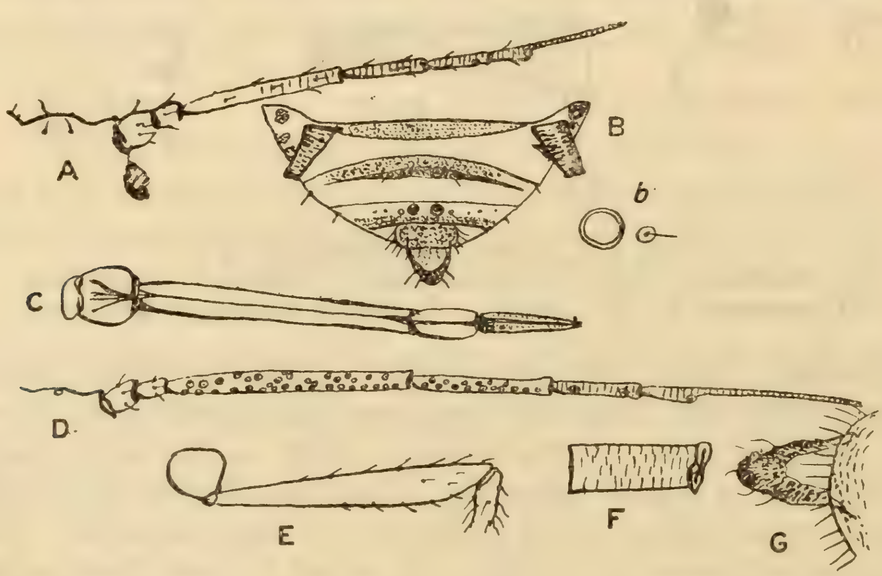

Fig. 18. *Aphis cynarae,* sp. n. ;
A, antenna of apterous ♀ ; B, end of abdomen ; (*b*) pore and hair on abdomen ; C, proboscis. D, antenna of alate ♀ ; E, hind femur ; F, cornicle ; G, cauda.

pale, dark on apical half of the femora and the tip of the tibiae and the tarsi. Wings normal, with pale brown veins and stigma. Basal segment of the antennae a little wider but no longer than the second ; the third the longest, with 35 to 50 sensoria scattered over its whole surface ; the fourth half as long as the third, with 14–18

sensoria over its whole length, mostly on one side ; fifth segment shorter than the fourth, with one large sub-apical sensorium and a smaller one below the middle ; sixth as long as the fourth and fifth, its basal area about one-third the length of the flagellum ; the fourth to sixth imbricated. Proboscis rather long and thin, reaching to the base of the third pair of legs ; apical segment dark, rather narrow and pointed and longer than the penultimate segment. Cornicles rather short and cylindrical, faintly imbricated, a little longer than the cauda, which is bluntly cone-shaped, with two pairs of lateral hairs and slightly spinose, pale brown, darker at the edge ; anal plate brown, hairy ; two large round pores on the segment in front of the cauda, with a distinct hair on the outside of each. Femora and tibiae hairy. *Length*, 2·5 mm.

Apterous viviparous female.—Pale ; head and pronotum bright brown ; abdomen with transverse lines of small black specks and with broad brown median bars between the cornicles down to the tail ; cauda small, pale, with dark brown edge ; cornicles, legs and antennae brown, the tibiae being paler ; proboscis thin, pale, except at the apex, reaching just past the second pair of legs, up to the third pair. Antennae less than half the length of the body ; the basal segment much wider than the second, the third the longest ; the fourth less than half the length of the third, and longer than the fifth ; sixth as long as the fourth and fifth, its base less than one-third the length of the flagellum ; third segment paler than the others. Proboscis as in the alate female. Legs rather thick, especially the femora ; femora and tibiae hairy. The brown cornicles slightly expanding at the base, imbricated, longer than the cauda. Cauda brown apically, spinose, with two pairs of lateral hairs and one sub-apical dorsal one ; anal plate brown, spinose and hairy. The segment in front of the cauda with two large median pores and a hair on the outer side of each, and two similar but smaller pores on the next segment. *Length*, 2·5–3 mm.

EGYPT : Gizeh, 27.iii.08 (*F. C. Willcocks*).

Food-plant. Artichoke (*Cynara*).

Described from a series of spirit specimens and slides. This species lives in the flower-heads of the globe artichoke. It might equally well be placed in *Siphocoryne*, except for the cornicles. The pores on the apical part of the abdomen are very marked. The colour cannot be given.

Aphis punicella, sp. nov. (fig. 19).

Alate viviparous female.—Head black, slightly shiny ; eyes brown. Antennae with two basal segments black ; third pale at base, rest black ; fourth, fifth and sixth black. Pronotum black, green in front and behind ; thoracic lobes black and shiny. Abdomen green to dark green ; cornicles black, with a conspicuous dusky area on the middle and slightly posterior to base of each cornicle ; three prominent lateral black spots in front of the cornicles ; cauda yellowish green. Insertions of wings yellowish ; costa smoky ; cubitus pale yellow ; stigma smoky. Legs ochreous, apical half of third femora dusky ; apex of first to third tibiae black ; tarsi black. Anal plate dusky ; sternal plate black. Head with small frontal processes, raised in the middle ; two median incurved capitate hairs and one on each lobe curved outwards. Antennae shorter than the body ; the basal segment a little wider, but no longer than the second ; the third a little shorter than the sixth, with 6–9 sensoria over its whole length ; the fourth a little shorter than the third and a little longer

than the fifth, with 0–5 sensoria ; the fifth with a single apical sensorium ; the sixth as long as the fourth and fifth, its basal area one-third the length of the flagellum ; third to sixth imbricated. Proboscis reaching to near the second coxae, acuminate, the apical segment longer than the penultimate. Pronotum with a blunt papilla on each side. Cornicles long, but shorter than the third antennal segment, striate at the base, becoming imbricate and then practically unadorned at the apex. Cauda about half as long as the cornicles, with three hairs on each side. Anal plate with six prominent long hairs and a few others. Legs with pale hairs. *Length*, 1·2–1·5 mm.

Apterous viviparous female.—Pale yellowish-green to green ; head dull yellowish green ; eyes brown. Antennae with the two basal segments of the same colour as the head ; the third pale ochreous, with smoky apex ; the other segments smoky. Thorax and abdomen green and yellowish green ; cornicles blackish ; cauda pale ochreous. Legs pale ochreous. Apex of tibiae dusky ; tarsi black ; coxae greenish. Venter green or yellowish green. Antennae shorter than the body, the

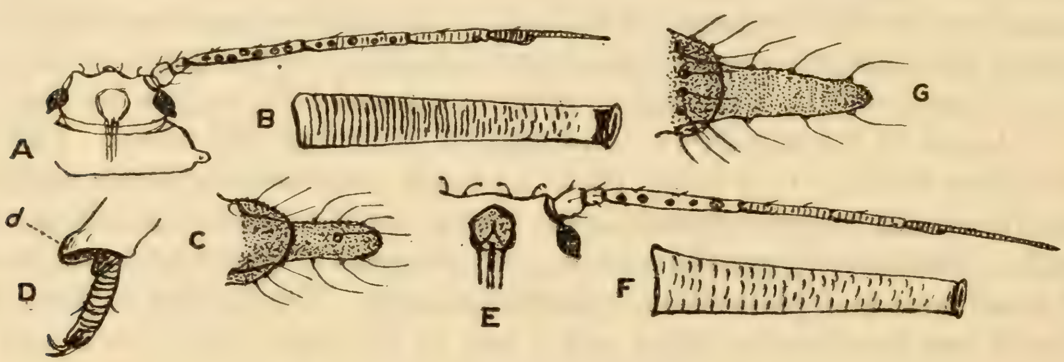

Fig. 19. *Aphis punicella*, sp. n. ;
A, head, antenna and pronotum of alate ♀ ; B, cornicle ; C, cauda ;
D, tarsus and cowl-like end of tibia (*d*). E, head and antenna of apterous ♀ ;
F, cornicle ; G, cauda and anal plate

basal segment larger than the second ; the third a little shorter than the sixth and a little longer than the fourth, with 4–5 sensoria ; fourth a little longer than the fifth, the latter with the usual sub-apical sensorium ; the sixth a little shorter than four and five, its basal area nearly one-half the length of the flagellum ; the sixth dusky. The dark cornicles slightly expanding at the base, nearly as long as the third antennal segment, imbricated. Cauda about half as long as the cornicles, blunt, with three hairs on each side and slightly spinose. The dark anal plate with three marked long hairs on each side. Legs shorter and thicker than in the alate female ; apices of the tibiae prominently overlapping the basal tarsal segment on one side ; tibiae with many hairs and a few on the apex of the femora. Proboscis nearly reaching the third pair of coxae. *Length*, 1–1·3 mm.

Egypt : Gizeh, 29.iii.1909 (*F. C. Willcocks*).

Food-plant. Pomegranate (*Punica granatum*).

Described from spirit specimens sent me by Mr. Willcocks and his colour notes on this species. The apterae are very distinct, the third antennal segment having sensoria. The curious cowl-like ends to the tarsi, especially to the hind tarsi, are also very characteristic. The cephalic hairs are fine, short and slightly capitate.

This cannot be Passerini's *Aphis punicae* as he describes the apterous female as having the cornicles " mediocria alba apice nigra " and the antennae as " albae." His full description of *Aphis punicae* is as follows :—" *Femina vivipara aptera* ovato-oblonga, tumida, atro-viridis, albo-pulverulenta vel nuda. Antennae albae corpore breviores, oculi nigri. Abdomen prope marginem tumidulum impresso-punctatum, apicem versus pallidiusculum. Nectaria mediocria alba apice nigro, caudam albam duplo superantia. Long, $\frac{3}{8}$, $\frac{1}{2}$ $'''$."

Aphis parvus, sp. nov. (fig. 20).

Alate viviparous female.—Dark. Antennae not quite as long as the body, brown ; the two basal segments and the sixth somewhat darker ; basal segment broader, but of the same length as the second ; third segment longer than the fourth, but shorter than the sixth, with 7–10 sensoria along its whole length ; fourth and fifth segments about equal, basal area of the sixth about one-third the length of the flagellum, all

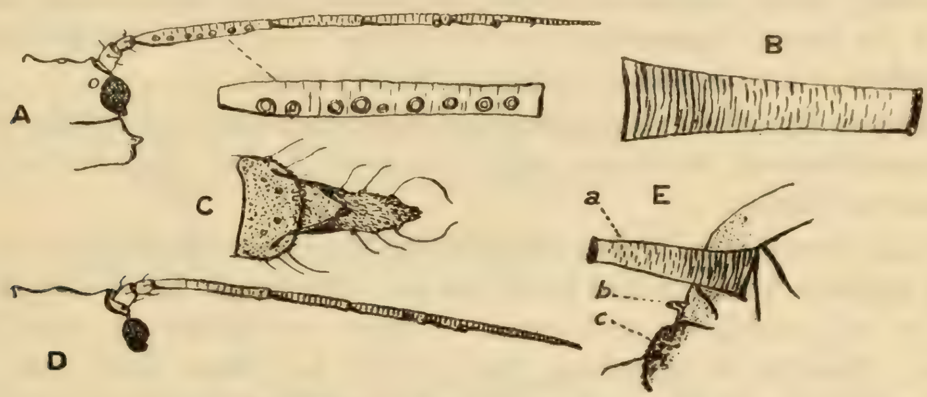

Fig. 20. ***Aphis parvus*, sp. n. ;**
A, head, antenna and pronotum of alate ♀, B, cornicle ; C, cauda and anal plate. D, head and antenna of apterous ♀ ; E, (*a*) cornicle, (*b*) papilla, (*c*) anal plate.

the segments striate or imbricate. Eyes large, red and black. Legs pale, with the apices of the femora and tibiae and all the tarsi dark ; moderately long. Cornicles black, rather short and thick, markedly striate at the base, becoming imbricated, but unadorned at the apex ; from about one-half to one-third the length of the third antennal segment. Cauda black, about four-fifths the length of the cornicles, and projecting far beyond them ; bluntly acuminate, spinose and with three pairs of lateral hairs. Wings large, with pale brown stigma and veins. Proboscis reaching to the second pair of legs. *Length,* 1·2–1·5 mm.

Apterous viviparous female.—Antennae a little shorter than the body ; two basal segments dark ; third, fourth and fifth, except apex of latter, pale ; sixth dark ; basal segment broader but no longer than the second ; the third a little longer than the fourth, but shorter than the sixth ; the fourth and fifth about equal ; sixth with the basal area one-third the length of the flagellum ; all the segments finely or clearly imbricated to striated. Pronotum with a blunt papilla on each side. Proboscis reaching past the second pair of legs. Eyes red. Cornicles black, somewhat expanding apically, markedly striate at the base, then imbricated, the apex being unadorned. Cauda black, large, from one-half to two-thirds the length of the cornicles, projecting

beyond them, spinose, with three pairs of lateral hairs; anal plate black. A blunt papilla between the cornicles and cauda on each side. Legs pale, with the apices of the femora and the tibiae and tarsi dark. *Length*, 1·2–1·5 mm.

EGYPT: Ghezireh, 20.xi.07 (*F. C. Willcocks*).

Food-plant. Chrysanthemums.

Described from a number of alate and apterous specimens in alcohol. The colour cannot be given, but they were both of a dark hue, the body of the alate female being paler, probably greenish with dark lateral spots.

This might at first sight be mistaken for Koch's *Aphis chrysanthemi*, but it has only 7–10 sensoria on the third antennal segment in the alate female, whereas in *A. chrysanthemi* there are 22–28 sensoria, and the cauda is shorter and more rounded in that species, which is also considerably larger; my alate females measuring 1·8 to 2·5 mm. The chrysanthemum aphis of Koch is black and green and this has been taken to be the same species as *Aphis cardui*, L., by Buckton and Schouteden; both species certainly have a green and black abdomen dorsally in the alate female. As I have not yet found *chrysanthemi* on thistles and cannot get that species to breed on any *Carduus*, I am temporarily retaining Koch's species.

I have another British chrysanthemum aphid common on the ox-eye daisy (*Chrysanthemum leucanthemum*), which also might be *cardui*, L., but again it does not occur at any time on thistles.

Walker also describes an *Aphis chrysanthemi* (Zoologist, vii, App., p. lvi, 1849) in which the apterous female is dull green and the alate female has a very dark brown abdomen or only variegated with green. I fancy two species are mixed up in his description. Buckton in describing *Aphis cardui*, L., (Mono. Brit. Aph., ii, p. 92, pl. lxvii) says the young are green and that it is subject to variation in colour, some being bright golden yellow, with a variable black patch on the dorsum.

The other typical chrysanthemum aphid is *Macrosiphoniella chrysanthemi*, Del G. (p. 112). Buckton's *Siphonophora circumflexa*, which is a *Myzus* and not a *Macrosiphum*, is also common on these plants under glass, and *Rhopalosiphum diantha*, Sulzer, damages them. Out of doors one may find this last species and also *Aphis rumicis*, L., injuring chrysanthemums.

Aphis maidis, Fitch.

EGYPT: Gizeh, Cairo, on wheat (*F. C. Willcocks*).

Many apterous and some alate ♀♀, which agree with my American specimens.

Aphis laburni, Kalt.

Kaltenbach, Mono. Pflanz., p. 85 (1843).

EGYPT: Gizeh, 1909, on young shoots of *Robinia* sp. (*F. C. Willcocks*).

I cannot separate these insects from the laburnum aphis of Europe.

Aphis medicaginis, Koch.

Koch, Die Pflanz., p. 94, pl. xvii, figs. 125 & 126 (1857).

EGYPT: Ghezireh, 8.iv.09, on *Medicago* sp. (*F. C. Willcocks*).

Alate and apterous females.

Myzus tetrahodus, Walker.

Siphonophora rosarum, Koch (*nec* Kalt. and Walk.).

Walker, Ann. Mag. Nat. Hist., (2) iii, p. 302 (1849); Koch, Die Pflanz., p. 180, pl. xxxiii, figs. 247–248 (1857).

EGYPT: Gizeh, Cairo, on roses (*F. C. Willcocks*).

This rose aphid is easily recognised by the capitate hairs on the head and body, and by its black cornicles. Buckton's *Siphonophora rosarum* is not the same as Koch's, nor is it Kaltenbach's, nor Walker's, which are the same. Walker's *Aphis tetrahodus* has black cornicles in the alate female just as Koch describes and figures for his *rosarum*, and I am sure they are the same (*vide* table of Rose Aphides, p. 112).

Myzus asclepiadis, Pass. (figs. 21, 22).

Aphis nigripes, Theobald.

Passerini, Aphid. Ital., pp. 22 and 25 (1863); Theobald, Bull. Ent. Res. iv, p. 327, fig. 10 (1914).

UGANDA: Kitoma, 6.xi.13 (*C. C. Gowdey*). TRANSVAAL: Onderstepoort, 21.iv.14 (*G. Bedford*); Pretoria, 1.viii.13 (*G. Bedford*). ITALY (*Passerini*).

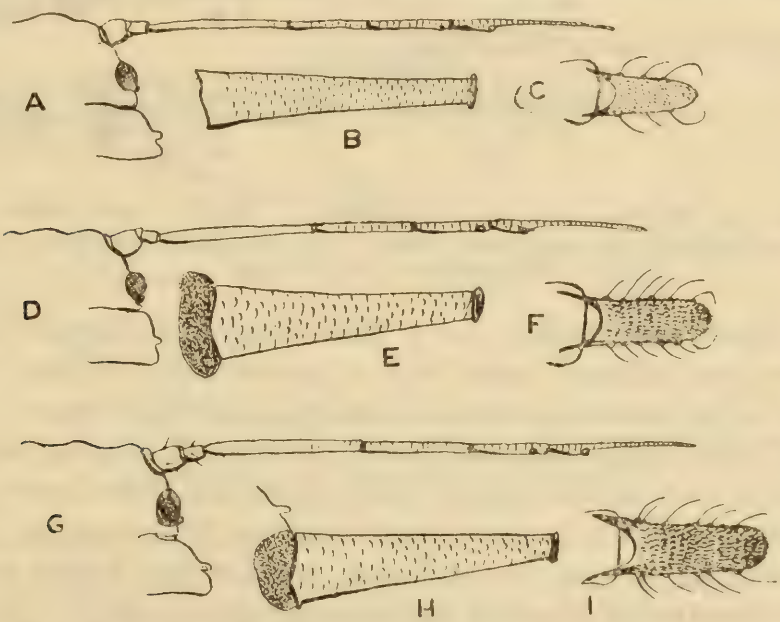

Fig. 21. Head, cornicle and cauda of: A–C, *Myzus nerii*; D–F, *M. asclepiadis*, G–I, *M. asclepiadis* var. *nigripes*.

Food-plants.—Asclepias lunata, *Gomphocarpus fruticosus* and *Salix* sp.

Schouteden and others have placed *A. asclepiadis*, Pass., as a synonym of *A.* (*Myzus*) *nerii*, Boyer. As the *Salix* aphid sent me by Mr. G. Bedford from Pretoria did not agree with *A. nerii* I described it as a new species. Since then I have had a similar aphid from *Asclepias lunata* and *Gomphocarpus fruticosus* and find that they agree with the *Salix* species so closely that I am uniting them. A large number sent me by Mr. Bedford from the *Gomphocarpus* (a plant used to adulterate senna) vary to some extent. This species is

yellow to yellowish green, mainly the former; that is, the same colour as *Aphis nerii.* The antennae of the alate female are black, and in the apterous female the third and fourth segments are pale, or the base only of each segment is pale; the cornicles are jet-black, as are also the cauda and anal plate; the hind legs are all dark, but the fore and mid legs have paler bases to the femora and most of the tibiae pale. In the form on *Salix* the colour is the same, but in the apterous female all the legs are dark, whilst in the alate female only the hind legs are all dark. In this form (*nigripes*, Theo.), the antennae of the apterous female may be all dark or pale at the base of the third and fourth segments. Both forms have a large dark patch at the base of the cornicles in alate and apterous insects. The third segment of the antennae in the alate female has from 6 to 11 sensoria and 0–1 on the fourth segment in specimens from Asclepiads; but in the *Salix* specimens the third has from 8 to 12 sensoria (fig. 22). The cauda has six to seven pairs of hairs on each side in both winged and wingless insects. On the pronotum is a blunt papilla on each side, also one between the cornicles and

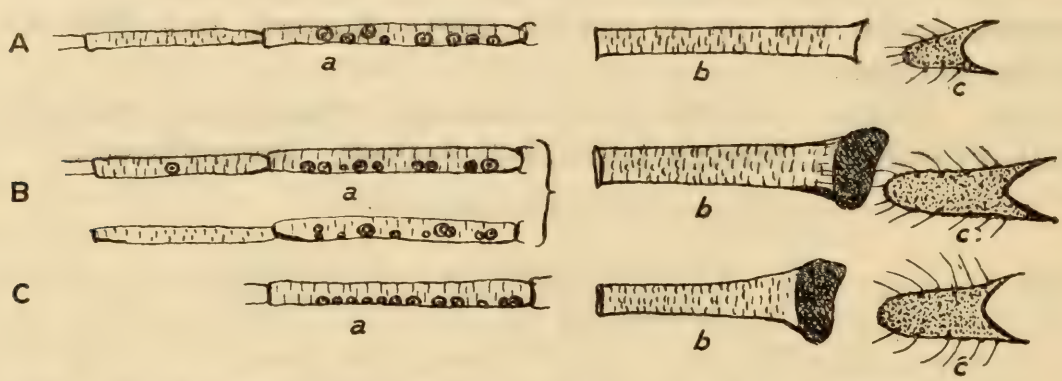

Fig. 22. A, *Myzus nerii*, Schr., alate ♀; B, *M. asclepiadis*, Pass.; C, *M. asclepiadis* var. *nigripes*, Theo.; (*a*), antennal segments 3 and 4; (*b*), cornicle; (*c*), cauda.

cauda. The yellow alate female has a black head and thoracic lobes, and the abdomen shows two darkened areas with a median paler division; the venter is yellow, except for the black mesosternal plate and the black coxae. The wings are slightly tinged with pale yellowish-brown; veins and stigma brown. On the abdomen there are four pairs of minute black specks and three dusky pairs of lateral spots. The apterous female has two black spots on the pronotum, a line of small black spots (seven in number) on each side, a black line before and behind the pronotum, and one uniting the first pair of small lateral spots. The antennae of the apterous female have the fifth segment shorter than the fourth.

In *A. nerii*, Boyer, the colour is the same and the insect has the same general appearance; but in the alate female the black cornicles are thinner and more uniform in size, the cauda has only 3–4 pairs of lateral hairs, and in both alate and apterous females I can see no trace of the black spots at the base of the cornicles; moreover, in the apterous female the fifth antennal segment is as long as the fourth, and the black cauda has only 3 to 4 pairs of lateral hairs.

It thus seems clear that Passerini was quite correct in placing the yellow Asclepiad aphis as a distinct species from that of the oleander (*Nerium oleander*). The nymphs in both species have black wing-pads and black lateral specks, as in the apterous females.

Genus Neotoxoptera, nov.

Head with pronounced frontal lobes. Antennae in alate female longer than the body ; third segment with sensoria. Wings with the first oblique vein once forked, as in *Toxoptera* ; hind wings with normal venation. Cornicles fairly long, clavate. Cauda bluntly pointed, not as long as the cornicles. Eyes large.

This genus differs from *Toxoptera* in the long antennae and from *Rhopalosiphum* in the anterior wing venation.

Neotoxoptera violae, sp. nov. (fig. 23).

Alate viviparous female.—Black ; abdomen yellowish brown, black around the margin. Head dark, broad ; eyes large and black. Antennae about twice as long as the body, thin ; first segment large ; second small, both black ; remainder of antennae paler ; third segment longer than the fourth, with 20 to 25 sensoria spread over its whole length ; fourth segment a little longer than the fifth, the latter with

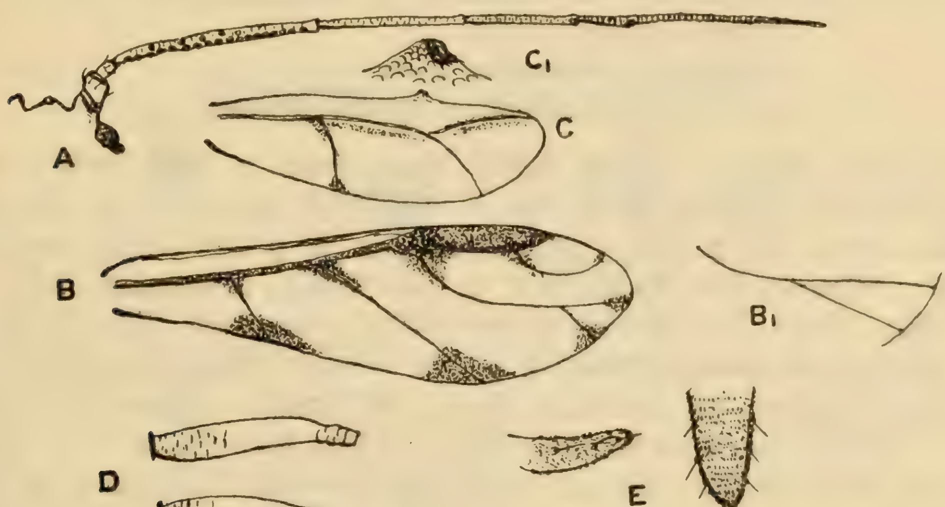

Fig. 23. *Neotoxoptera violae*, sp. n., alate ♀ ; A, head ; B, front wing ; C, hind wing ; C_1, hooked process on hind wing ; D, cornicles ; E, cauda.

a single prominent sub-apical sensorium ; sixth as long as fourth and fifth, the basal area half the length of the fifth ; one large and several small sensoria at the junction of the basal area and flagellum ; all the segments imbricated and with a few fine hairs. Proboscis rather narrow, pale, slightly dusky at the apex, reaching past the second pair of legs ; the apical segment twice as long as the penultimate, base somewhat enlarged laterally. Legs long and thin ; pale, except the apices of the femora and tibiae and all the tarsi, which are dusky black ; tibiae hairy, a few hairs on the femora ; tarsi and femora showing signs of imbrication ; ungues dark. Wings ornamented with dusky brown areas, veins brown. Cornicles dark, fairly long, slightly clavate, flared at the tips, showing corrugations on the basal area, but no marked ornamentation apically. Cauda dark, bluntly pointed, spinose, with three pairs of lateral hairs, about half the length of the cornicles. *Length*, 1·5–2 mm. ; wing expanse, 7–8·5 mm.

Apterous female.—"Dark reddish-brown. The young forms have a greenish grey head. Thorax and abdomen reddish, the last segment green."—*G. Bedford.*

TRANSVAAL: Onderstepoort, 24.vii.14 (*G. Bedford*).

Food-plant. Violets (*Viola* sp.).

Described from several alate females. It is a very marked and pretty species, which bears a strong superficial resemblance to Essig's *Rhopalosiphum violae* described from America, but the marked wing venation at once separates it, in spite of the fact that the ornamentation of the wings is very similar; it differs also in colour. Mr. Bedford writes that "the winged form was common for about two weeks. Then this aphis disappeared from the violets. I have not seen them since." The colours were noted when alive and also the colours of the young and apterae, none of which were sent me.

Chaitophorus populi, L. (fig. 24).

Aphis populi, L.
Aphis populeti, Panz.
Aphis populi-albae, Boyer.
Chaitophorus versicolor, Koch.
Arctaphis populi, Walk.
Chaitophorus leucomelas, Koch.
Chaitophorus leucomelas v. *lyratus*, Ferrari.

Linnaeus, Syst. Nat., ii, p. 736 (1767), Faun. Suec., p. 997 (1789); Reaumur, Ins., iii, pl. 26, figs. 7–11 and pl. 27, figs. 1–14 (1737); Fabricius, Sp. Ins., ii, p. 386 (1781), Ent. Syst., iv, p. 216 (1794), Mant. Ins. ii, p. 326 (1802), Syst. Rhyng., 298 (1803); Schrank, Fn. Boica, ii, 1, p. 113 (1801); Hausmann, Illig. Mag., i, p. 443 (1802); Rossi, Fn. Etrusc., p. 260 (1790); Samouelle, Ent. Comp., i, p. 4 (1819); Kaltenbach, Mono. Pflanz., i, p. 126 (1843); Ratzeburg, Forst. Ins., iii, p. 218 (1844); Walker, Ann. Nat. Hist. (2) i, p. 445 (1848); Panzer, Faun. Ins. Germ. xxvii, p. 18 (1812); Boyer de Fonscolombe, Ann. Soc. Ent. France, x, p. 187 (1841); Walker, Cat. Homop. Brit. Mus., p. 948 (1852); Koch, Die Pflanz., p. 10, pl. ii, figs. 14 and 15 and p. 4, pl. 1, figs. 5 and 6 (1857); Passerini, Aphid. Ital., p. 57 (1863); Ferrari, Spec. Aphid. Liguriae, p. 232 (1872); Buckton, Mono. Brit. Aphid., ii, p. 140, pl. lxxxii, figs. 3–5 (1877); Wittaczil, Denks. Akad. Wiss. Wien, p. 387, pls. i and ii (1884); Schouteden, Mém. Soc. Ent. Belg., xii, p. 213 (1906).

EGYPT: Gizeh, 3.i, and 31.iii.1910 (*F. C. Willcocks*).—Widely distributed in Europe.

Food-plants. Populus albus, P. tremula, P. dilatata, P. nigra and *Prunus* sp.

Mr. Willcocks found this *Chaitophorus* on the under sides of the leaves of *Populus albus* in Egypt in all stages and noticed that it produced considerable quantities of honey-dew at certain times; the upper surface of the leaves was black with *Melliola* sp., a saphrophytic fungus on the honeydew. There is no doubt that it is the European *Chaitophorus populi*, L., which is a very variable species as regards colour. The colours of the living insects are as follows:—

Alate viviparous female.—"Head shiny black; eyes very deep red to red. Antennae with 1st segment black, darker than 2nd; 2nd dusky or dusky ochreous; 3rd with basal ⅓ dusky ochreous, rest black; 4, 5 and 6 black. Pronotum dark greenish, with broad shiny black prothoracic collar; mesothorax shiny, black; hairs pale. Wings with the costa dusky, cubitus yellowish, stigma black, veins ochreous; wing insertions yellow. Legs, 1st pair with femur and tibia ochreous or ochreous brown,

tarsi black; 2nd with femur black, tibia ochreous shaded at base, tarsus black; 3rd with femur black, tibia very dark brown to almost black, coxae and trochanters black. Abdomen green or very dark olive-green, heavily barred with black, with pale hairs. Cornicles black. Cauda grey or greenish yellow. Also five large lateral irregular-shaped spots between base of abdomen and cornicles, and a sixth spot below and posterior, but touching the base of the cornicle. Head, thorax, sternal plate and venter shiny black; apex and base of proboscis black, median area ochreous brown; abdomen dull darkish green, anal plate black. One small specimen had the head and pronotum blackish brown, thorax black and abdomen blackish brown, paler at sides and apex.

Apterous female.—"Head of varying shades of brown, from dark blackish-brown to bright reddish-brown or pale brownish-orange; shiny; hairs pale; eyes prominent, red. The head has two sub-median areas rather darker in hue, which are continued posteriorly over the thorax. Antennae with 1st segment dusky, 2nd dusky ochreous; 3rd ochreous, apical $\frac{1}{3}$ blackish-ochreous, darkening towards apex;

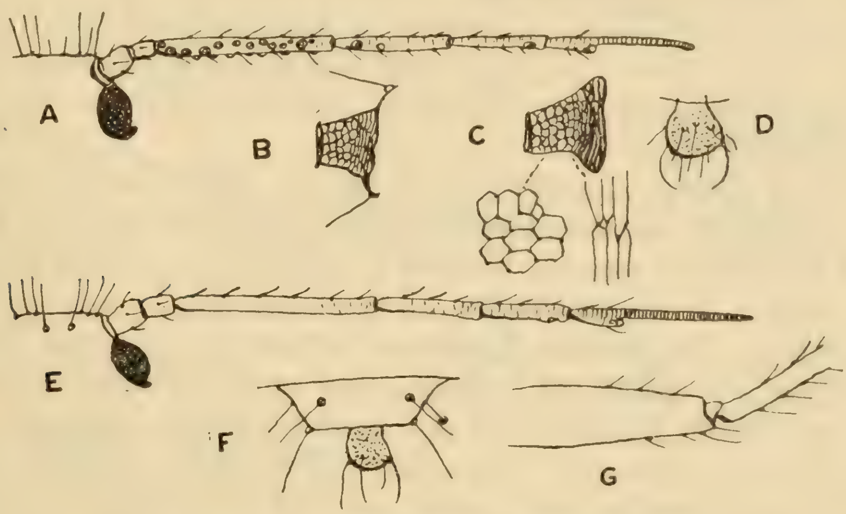

Fig. 24. ***Chaitophorus populi*, L.;**
A, head and antenna of alate ♀; B, cornicle; C, cornicle of apterous ♀; D, cauda; E, head and antenna; F, cauda; G, front femoro-tibial joint.

sometimes the 3rd segment is much paler; 4th, 5th and 6th black. Pronotum of the same colour as the head, shiny. Meso- and meta-thorax same as prothorax, but in some specimens the lateral margins are yellowish green; shiny; hairs pale. The brown of the thoracic region varies in hue from dark to reddish to light brownish orange. Abdomen shiny, dark brown, blackish brown or reddish brown, with paler and darker markings of the same colour. A large green or yellowish green patch in median area of basal $\frac{1}{3}$ of abdomen. Abdomen yellowish green or green at sides; apical segments yellowish green. Cauda yellowish green or faintly ochreous. Cornicles dusky to black, paler at the apex. Legs, 1st pair ochreous, tarsus dusky; 2nd femur blackish or dusky olivaceous, coxae dusky, tibia ochreous brownish at knee and dusky at apex, tarsi black; on 3rd legs, femur black, tibia ochreous, dusky to blackish brown, tarsus black. Underside of head brownish or orange; proboscis reaching beyond the 3rd coxae; thorax and abdomen dull greenish. Cauda dusky.

Young larva.—" Head brownish ; eyes red. Two basal antennal segments dusky; 3rd pale ; 4th and 5th black, base of 4 smoky. Pronotum brownish. Abdomen, meso- and meta-notum green, heavily mottled with purplish. Cornicles green. Legs green, with dark tarsi. Hairs on body pale.

Larva.—" Head and thorax reddish brown, or brownish orange ; eyes dark red. Abdomen and mid thorax green or yellowish green mottled with reddish brown, purplish brown or purplish. Antennae with segments 1 and 2 dusky, 3 pale, dusky at apex ; 4 and 5 black. Legs greenish, or 1st pair sometimes tinged with ochreous, tarsi dusky. In some specimens tibiae pale and femora only tinged with green.

Nymph.—" Head reddish brown ; eyes deep red. Antennae with segments dusky, 2 paler, 3 pale, 4 pale with dark apex, 5 and 6 black. Pronotum of same colour as head ; hairs on head and pronotum pale. Meso- and meta-notum green or obscure pallid greyish-green ; position of thoracic lobes indicated by reddish or purplish colour. Wing-pads of same colour as meso- and meta-thorax. Abdomen bright yellowish-green mottled with dark or paler reddish-brown or dark purplish. In some specimens the head and thorax are light reddish-brown and the abdomen yellowish green and light reddish-brown. Underside of head and prothorax reddish brown ; venter green ; coxae green ; proboscis reaching to 3rd coxae, very dark reddish-brown at base, median area pale, tip black. An active species. Found from 8th December to March."—F. C. W.

The antennae of the alate ♀ have the basal segment larger than the second, the third the longest, with 21–25 sensoria along its whole length; the fourth is a little longer than the fifth and has two sensoria, the fifth a subapical one ; basal area of the sixth nearly half as long as the flagellum; all segments faintly imbricated, flagellum striated. Cornicles with marked hexagonal reticulation on apical half, then the reticulations gradually spread out laterally, until at the base the cornicle has linear ornamentation. Cauda globular. In the apterous female there are no sensoria on the third or fourth segments ; hairs long, chiefly on one side of each segment; fourth and fifth segments often nearly equal, now and then the fifth a little the shorter. Cornicles as in alate female. The femora somewhat enlarged; legs with longish hairs in both forms.

These Egyptian specimens exactly agree with the European *C. populi*, except that in the latter I have not been able to detect the two sensoria on the fourth antennal segment of the alate female.

Callipterus ononidis, Kalt. (figs. 25, 26).

Aphis ononidis, Kalt.
Chaitophorus ononidis, Koch.
Myzocallis ononidis, Pass., Ferrari.
Chaitophorus maculatus, Buckton.
Callipterus trifolii, Monell.

Kaltenbach, Ent. Zeit., iii, p. 173 (1846) ; Koch, Die Pflanz, p. 5, fig. 7 (1857) ; Passerini, Aphid. Ital., p. 53 (1863) ; Ferrari, Aphid. Liguriae, p. 75 (1872) ; Buckton, Ind. Mus. Notes, iv, p. 277, pl. xvii, fig. 1 (1899) ; Monell, Can. Ent., p. 14 (1882) ; Williams, Spec. Bull. 1, Univ. Nebr. Dept. Ent., p. 8 (1891) ; Osborn, Proc. Iowa Ac. Sci., i, pt. 2, p. 129 (1892) ; Osborn and Sirrine, Proc. Iowa Acad. Sci., i, pt. 3, p. 98

(1893); Sanderson, Twelfth Ann. Rept. Del. Agri. Exp. Sts., 1900, p. 207 (1901); Sanborn, Kansas Univ. Sci. Bull., 3, no. 8, pp. 251, 252 and 262 (1906); Davis, Ann. Ent. Soc. Amer, i, p. 256 (1908); Folsom, Bull. 134, Ill. Agri. Exp. St., p. 175 (1909); Davis, Journ. Econ. Ent., iii, p. 419 (1910); Gillette, Journ. Econ. Ent., iii, p. 369 (1910); Smith, Ann. Rept. N.J. State Mus., 1909, p. 116 (1910); Williams, Univ. Studies, x, no. 2, p. 32 (1911); Morrison, Fifth Ann. Rept. St. Ent. Ind., 1911–1912, p. 216 (1912); Davis, U.S. Dept. Agric. Bur. Ent., Tech. Ser. no. 25, pt. ii, p. 40 (1914).

Alate viviparous female.—Head very pale greenish-ochreous to pale yellowish-green. Eyes red, reticulations pale, somewhat ochreous; four dusky tubercles arranged as shown in fig. 25 (A), rather inconspicuous, between the bases of the antennae. Two dusky lines in the median area of the head. Antennae with the

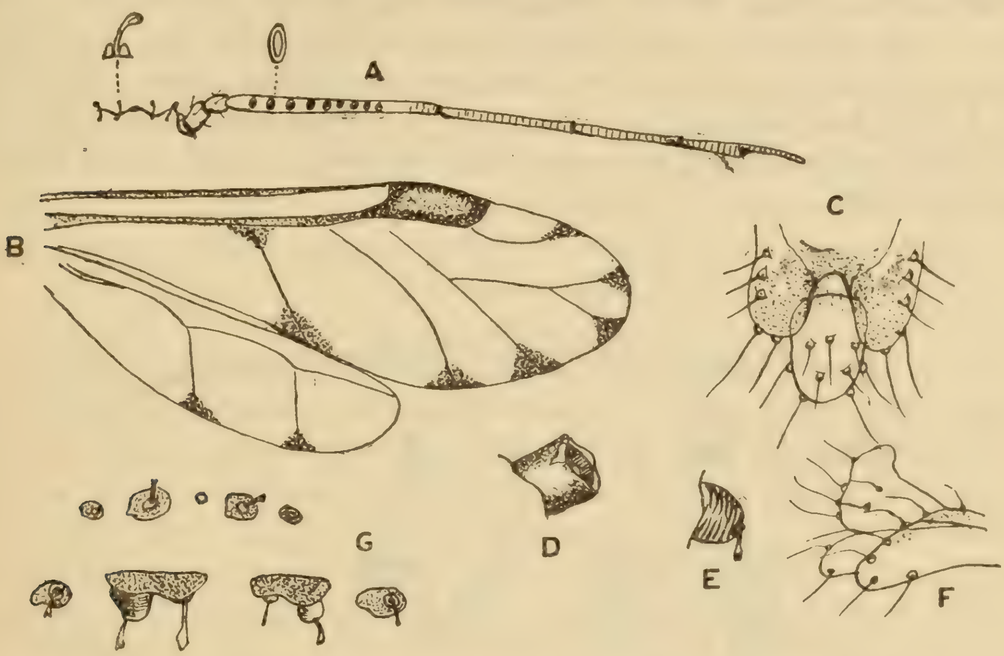

Fig. 25. *Callipterus ononidis*, Kalt., alate viviparous ♀; A, antenna; B, wings; C, cauda and anal plate; D, cornicle; E, lateral tubercle of abdomen; F, side view of cauda; G, body spines.

two basal segments pale or pale smoky, third ochreous with dusky apex, fourth to sixth dusky. Pronotum of the same colour as head, with some dusky lines. Mesothorax pale, but dull ochreous or greenish (darker in some specimens than in others), rather translucent in appearance. Thoracic shields of the same colour, but darker. Abdomen a clear, bright, pale yellowish green or greenish yellow, with black spots; a lateral line of seven black spots, one being close to or against the anterior margin of the cornicles. Cauda and the anal plate of the same colour as the abdomen. Cornicles pale, a dusky ring at the apex. Wing insertions pale; costa smoky, pale at the base; cubital vein with basal one-third pale, the rest smoky or faintly greenish; stigma pale smoky. Legs ochreous; tarsi dusky. Venter pale yellowish-green; underside of head and thorax slightly more yellow. Antennae not as long as the body, of six segments, the first slightly longer and wider than the second; the third the longest, with eight to nine oval sensoria, not quite reaching the apex; fourth and fifth about equal in length, the latter with

a single sub-apical sensorium; the sixth about as long as the fifth, its basal area as long as, or a little longer than, the flagellum; fourth to sixth and apex of the third imbricated; the fifth and sixth almost annulated. Head with a small blunt median swelling and slightly raised on each side at the base of the antennae, with short, rather thick clavate hairs. Proboscis reaching a little past the base of the first pair of legs, rather thick and dusky at the apex. Wings about as long as the whole body, rounded apically, with ornamentation as in fig. 25 (B). The moderately long legs show no special peculiarities, except that the second pair are far behind the first and very close to the third, and that the tarsi are very dusky and sometimes the apices of the tibiae also; the latter have small pale hairs. Cornicles small and showing no special ornamentation. The cauda markedly bilobed, each lobe with two long hairs on the apex and three on the outside, arising from prominent tubercles. Anal plate pale, globular at the apex, projecting beyond the cauda and between the lobes, with some long hairs arising from marked tubercles. In balsam the abdominal spots each have a central clear area, from which arises a small tubercle bearing a thick hair expanded at the apex, of various forms; the black lateral tubercles each carry a thick hair expanding apically. *Length*, 2–2·5 mm.; wing expanse, 5–5·5 mm.

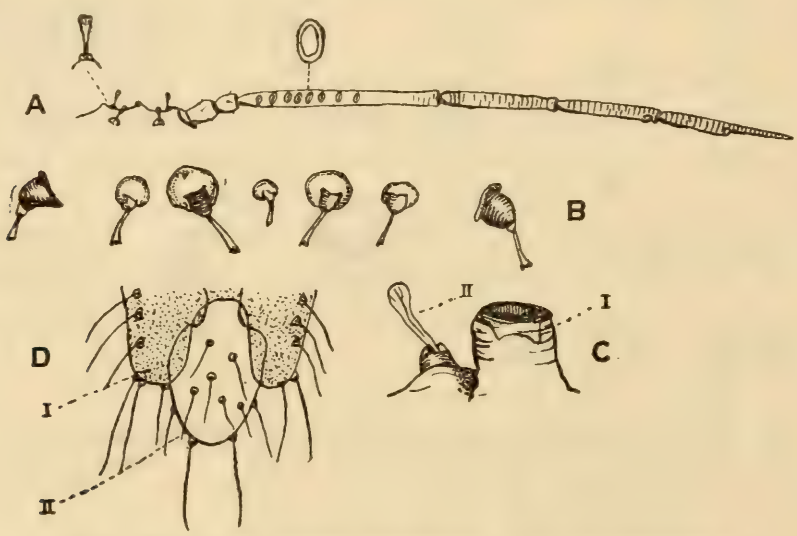

Fig. 26. *Callipterus ononidis*, Kalt., apterous viviparous ♀;
A, antenna; B, body hairs; C, (I) cornicle; C (II), body hair; D (I), cauda; D (II), anal plate.

Apterous viviparous female.—Uniformly ochreous to pale greenish-yellow, covered with dusky tubercles from which arise strong hairs with expanded apices. Eyes red. Antennae with segments one to three yellowish, fourth dusky ochreous, shading to dusky apically, fifth and sixth dusky. Legs ochreous, tarsi dusky. Cornicles short, of same colour as body, with dusky apical ring. Cauda of same colour as body. Head with capitate hairs. Antennae shorter than the body; the first segment longer and slightly wider than the second; the third the longest, with seven to nine oval sensoria, not extending to the apex; fourth and fifth nearly equal; the sixth about as long as the fifth, its basal area as long as the flagellum; fourth and fifth imbricated; sixth more or less annulated. Proboscis reaching

past the second pair of legs, dusky at the tip. First and second pair of legs close together, the third further away. Cauda as in the alate female. *Length*, 2 mm.

Larva (young).—When newly born, faintly tinged with green; dusky tubercles and bristle-like hairs arranged in four rows. Eyes bright red; legs and antennae pale. Older larvae pale yellowish-green, with dusky tubercles and hairs arranged in six rows. Legs faintly greenish; tarsi smoky. Eyes red. Antennae with the two basal segments pale yellowish-green; third pale and faintly smoky towards apex; four to six smoky. *Nymph* uniform pale yellowish-green. Cornicles with dark apical ring; tubercles dusky. Fore wing-buds shaded. Femora pale yellowish-green; tibiae ochreous; tarsi dusky. Eyes red. Antennal segments 1 and 2 pale yellowish-green, 3 and 4 pale, 5 and 6 smoky.

Alate male.—Head and thorax olive-green; abdomen pale yellowish-green, with conspicuous black markings. Similar to alate female, but smaller, with more slender body and the dusky tubercular areas on the dorsum of abdomen smaller. Head and thorax with a number of hairs arranged more or less regularly. The cephalic and thoracic hairs are unknobbed or but inconspicuously capitate, and those on the abdomen may also be capitate or not, being usually inconspicuously knobbed. Eyes dark red or blackish. Antennae dusky to black, reaching a little beyond the tip of the abdomen; third segment with 13 to 16 oval sensoria, more or less in a row; the fourth with three to five; the fifth with three to five, not including the usual distal one; and the sixth with one sensorium surrounded by several smaller ones at the tip. Proboscis not reaching the second coxae. Venation as in the alate viviparous female. Cornicles and cauda dusky, the latter edged with black; form as in the viviparous generation. *Length*, 1·3 mm.; wing expanse, 4·1 mm.

Oviparous female.—Apterous, general colour yellowish orange to orange when fully mature. Body usually yellowish when first reaching maturity, but as the ova, which are of an orange colour, begin to develop within the body they show through the semi-transparent skin, giving the conspicuous orange colour to the body.* Head and prothorax pale yellow; meso- and meta-thorax varying from yellow to orange according to age. Dusky tuberculate areas conspicuous. These and the black capitate hairs arranged as on the stem-mother. Eyes blackish or brownish black. Antennae not reaching the base of cornicles; basal segments concolorous with head, others gradually darkening toward apex. Legs pale yellowish, except tarsi; proximal halves of hind tibiae swollen and bearing 25 to 40 inconspicuous, irregularly placed, circular sensoria. Cornicles and cauda concolorous with abdomen, often dusky at margins. Cauda knobbed as in other forms, but the anal plate rounded at the tip and with no emargination. *Length*, 1·8 mm.

EGYPT: Kafr Zayat, 30.v.1910 (*F. Smith*); Gizeh, 2.vi.1910 (*F. C. Willcocks*). Also occurs in Europe, North America and India.

Food-plants. Berseem (*Trifolium alexandrinum*), *T. pratense*, etc., *Ononis spinosus*, *Medicago sativa*.

Redescribed from material sent me by Mr. Willcocks from Egypt, together with his colour notes from living specimens. The colours of the Egyptian specimens

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* In the American specimens sent me by Davis the ova in the females were black.

agree exactly with those of this insect I have found in England on Rest Harrow. The structural notes are from Egyptian, American and English specimens. It is a very marked species; the apterous females have the whole body studded with dark patches from which strong, apically expanded hairs arise. Willcocks found this aphis on the under side of the leaves of berseem and noticed that it formed a great quantity of honeydew.

Davis in his recent paper gives Buckton's *Chaitophorus maculatus* from India as a synonym of Monell's *Callipterus trifolii* and suggests that both may be the same as the European *ononidis*. I have not seen Indian specimens, but Davis has compared them with *trifolii*, Monell. The American specimens of *C. trifolii* which I have exactly agree with the African and European species and thus I have sunk it as a synonym of *ononidis*. The American specimens have the cornicles of just the same shape as the Egyptian, but both Buckton and Davis figure them slightly different; there is no doubt however that they are the same. The Indian food-plant is lucerne (*Medicago sativa*). In America Davis records *C. trifolii* on red clover (*Trifolium pratense*) and also reared it on white clover (*T. repens*), Alsike, English and mammoth clovers (all *Trifolium*); Das has found in India that the species called *maculatus* by Buckton lives on lucerne, but has never found it on *Trifolium*; just the reverse of what Davis finds in America. In England I have never seen it on *Medicago sativa*, but only on *Trifolium* and *Ononis*.

Genus Saltusaphis, nov.

Head very large, a long space between the frons and the eyes, which are large and prominent. Thorax large, the segments well defined; prothorax very large in the alate female, large in the apterous female. Body rather narrow, scarcely wider than head and thorax in the alate female, slightly more swollen in the apterous female. Antennae of six segments in both forms; longer than the body in the alate female, as long or a little longer in the apterous forms. Legs short, with the fore and mid femora expanded. Cornicles small and cup-shaped, marked with lines of spots. Cauda in both forms bifid, each branch bituberculate. Body hairs either fan-shaped or sickle-shaped, except at the apex. Proboscis short, not reaching the second pair of legs, which are widely separated from the first pair. Wing venation very marked (vide fig. 27).

This genus is founded on the marked cephalic structure, the posterior wing venation and the marked cauda. It is peculiar in that the apterae have the habit of jumping or skipping as in the Collembola. Only a single species is known so far.

Saltusaphis scirpus, sp. nov. (figs. 27, 28, 29).

Alate viviparous female.—Colours of alate female when alive:—"Head dusky ochreous tinged with green, a broad median dusky line; eyes red. Antennae with 1st and 2nd segments dusky; 3rd black, basal $\frac{1}{3}$ paler; 4th to 6th black. Pronotum yellowish green, with a broad median greyish area cut and edged by dusky lines. Mesonotum obscure brownish, tinged with green; wing insertions yellowish green. Abdomen pale yellowish green, with dusky markings. Cornicles and cauda dusky. Legs, 1st pair with femora pale to ochreous, shaded with dusky hue, tibia ochreous, tarsi dark; 2nd and 3rd pairs with femora dusky, tibiae and tarsi as in first pair.

Costa pale; cubitus faintly greenish; stigma pale, dusky medianly, margin darker. The abdomen, in addition to the dorsal markings, has a lateral row of 6 dusky spots, 4 in front of and 1 at base of and 1 behind the cornicles."—(*F. C. Willcocks*).

Colour of spirit specimens pale yellowish to greyish brown with dark markings. Head broad and very large, flattened in front, with two small median prominences and slightly raised against the base of the antennae; sides long, straight, slightly

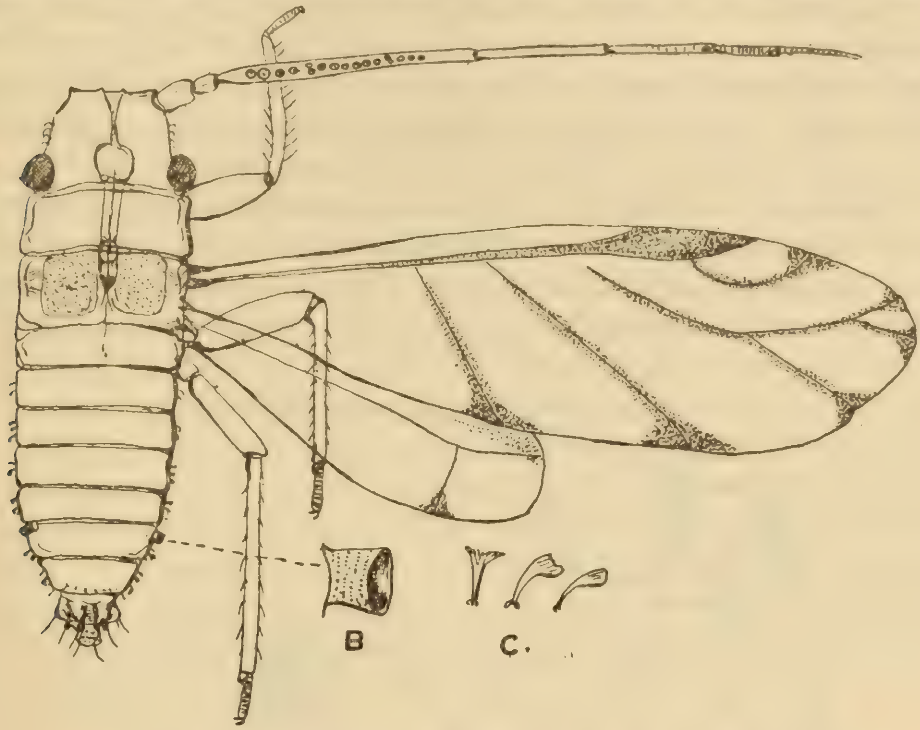

Fig. 27. *Saltusaphis scirpus*, sp. n., alate ♀; B, cornicle; C, body hairs.

diverging, with a few sickle-shaped thick hairs. Eyes large and prominent, placed far back. Prothorax pale, broad; mesothorax dark brown, longer than the prothorax; metathorax brown, shorter than the two former segments. Abdomen somewhat pointed, about the width of the thorax, with small dark lateral spots and

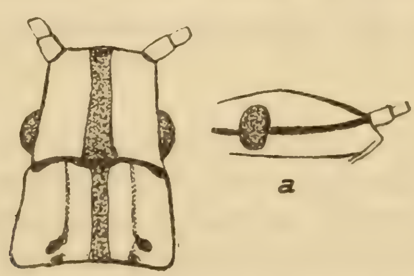

Fig. 28. *Saltusaphis scirpus*, sp. n.; cephalic and pronotal markings; (*a*) side view of head.

pale brown transverse bars; two near, but in front of, the cornicles. Cornicles small and dark, cup-shaped and ornamented with minute lines of specks. Legs rather short, pale, darkened at the apices of the femora and tibiae, and with dark tarsi; the fore and mid femora thick; the second pair of legs far behind the first;

tibiae hairy. Wings with brown veins and stigma, the membrane tinged where the veins of the fore wings join the border ; longer than the body and broad ; venation as shown in fig. 27. Antennae longer than the body ; first segment longer and slightly broader than the second ; the third the longest, narrowing towards the apex, with a line of 15–17 sensoria along about two-thirds of its length from the base ; fourth segment slightly longer than the fifth, the latter with the usual subapical sensorium ; the sixth not quite as long as the fourth and fifth, its basal area nearly as long as the flagellum ; all the segments from the third with minute black points instead of imbrications, apparently minute spines ; the sixth, especially the flagellum, strongly annulated ; the sensorium at the apex of the basal area of the sixth segment is single, large and round ; some rather long lateral hairs on the first to fourth segments. Cauda very marked, bituberculate, each tubercle being dented at the apex and with two long hairs ; general form shown in figure. Hairs of the body short, rather broad, fan-shaped and sickle-shaped. Proboscis rather short, not reaching the base of the second pair of legs. *Length*, 2 mm. ; wing expanse, 5·5 mm.

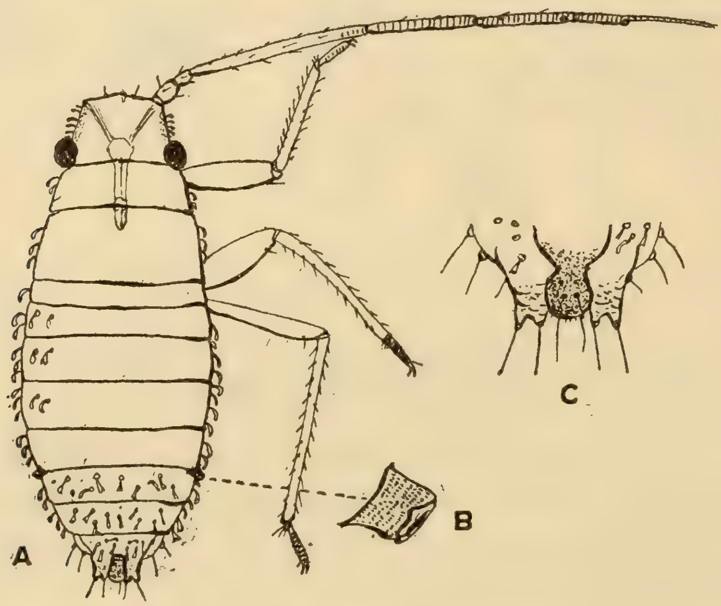

Fig. 29. *Saltusaphis scirpus*, sp. n. ;
A, apterous ♀ ; B, cornicle ; C, cauda.

Apterous viviparous female.—Colours of apterous female when alive :—" Yellowish, with dusky and blackish markings. Head pale yellow, with broad median dusky lines and a dusky lateral line from the base of antennae to front margin of eyes and carried on for a short distance behind the eyes. Eyes deep vinous red to red. Antennal lobes and segments 1 and 2 paler yellow ; segment 3 with the basal ½ ochreous, apical ½ black ; segments 4, 5 and 6 black. Prothorax yellowish, with dark markings. Meso- and meta-notum speckled with dusky points on a dusky submedian irregular line of pigment. Abdomen yellowish, speckled with dusky spots, which become so thick near the cornicles as to give the appearance of an uniform dusky area in this region. Cornicles dusky, with dark apical ring. Cauda very small and yellowish. Legs yellowish ; femora yellowish, tinged with dusky colour ; tibiae yellowish ; tarsi dusky. Proboscis very short. Underside of head

and thorax yellowish, venter of a greenish hue. There are two fleshy tubercles or processes on the dorsal surface of the penultimate segment. Body much flattened. Some are paler than others and the dusky areas are more intense."—F. C. W.

Pale yellowish-brown in spirit, speckled with black on the dorsum; dorsal line paler than the rest of the body and with three pairs of more pronounced black spots on the thorax. Head large, flattened in front; the sides long, straight, slightly diverging, with short, thick, sickle-shaped lateral hairs; the frons in some examples seems to be slightly projecting in the middle. Eyes large and black. Proboscis short, not reaching the second pair of legs. Antennae as long as or rarely slightly longer than the body, thin, of six segments; the first a little longer and wider than the second; the third the longest; fourth and fifth nearly equal; the sixth longer than the fifth, its basal area long, more than one-half the length of the flagellum; a single sensorium near the apex of the fifth and one at the junction of the basal area and flagellum of the sixth; apex of the third and all the fourth, fifth and sixth dark brown, the last three spinose and annulated. Thorax large and only a little wider than the head; prothorax large; mesothorax still larger; all three segments sharply defined. Abdomen narrow, of the same width as or slightly wider than the thorax; the segments well defined, especially those behind the cornicles; covered with large expanded hairs, some expanded apically, others sickle-shaped. Cornicles short, cup-shaped to bluntly tubular, pale, with fine speck-like ornamentation. Cauda pale, of somewhat similar form to that in the alate female, with some long hairs, which are slightly capitate; some hairs at the apex of the abdomen long and simple or slightly capitate, arising from prominent tubercles. *Length*, 2–2·5 mm.

EGYPT: Ghezireh, 3.v.10 (*F. C. Willcocks*).

Food-plant. Sedges (*Scirpus*).

This very marked aphid is described from a number of apterous females and two alate females. It is not only of very peculiar form and structure, but also is particularly noticeable on account of its jumping habits in the apterae. I have placed it in a new genus, as I know of no aphid with such an enlarged head or with similar venatior in the hind wings. Mr. Willcocks describes it as a very shy species, and says that the antennae are held out in front of the head, resting on the surface of the leaf when the insect is at rest. It springs from the plants on the slightest alarm, and then moves to some little distance.

Anoecia willcocksi, sp. nov. (figs. 30, 31, 32).

Alate viviparous female.—Black and green. Head black, dull; hairs pale; eyes black. Antennae black or deep sepia-brown. Thorax black, with a few pale hairs. Abdomen pale green, with conspicuous deep sepia-brown markings (black to naked eye), *viz.*, 2 sepia bars at base of abdomen; from the middle area to cornicles a large, very deep sepia, almost black, area; two bars of same colour posterior to it; five pairs of dusky lateral spots in front of cornicles. Rings of cornicles black and shiny. Legs black, hairs pale; first femora ochreous at base. Venter green, farinose; underside of head and thorax dull black. Wing insertions dusky, also veins. Head rounded in front, with rather long hairs. Eyes large and prominent; stemmata marked. Antennae as long as head and thorax; first two basal segments nearly equal, or first slightly larger; third longest, with 8 to 10 slit-like sensoria; fourth a little

more than one-fourth the length of third, with two oval sensoria on its apical half; fifth as long as fourth, with one large subapical sensorium; sixth longer than fifth, with short blunt nail, a single large sensorium at its base; long hairs on all segments. Thorax large; prothorax well defined, much narrower than mesothorax. Cornicles

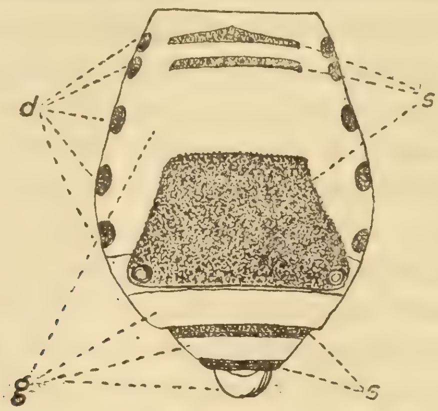

Fig. 30. *Anoecia willcocksi*, sp. n.; abdominal markings; (*g*) deep green; (*s*) deep sepia; (*d*) smoky black.

slightly projecting, obconical, dark, with hairs on the surface, opening round. Legs moderately long and thick; the tibiae and the tarsi hairy; the second pair a long way distant from the anterior pair and quite close to the third pair; ungues dark,

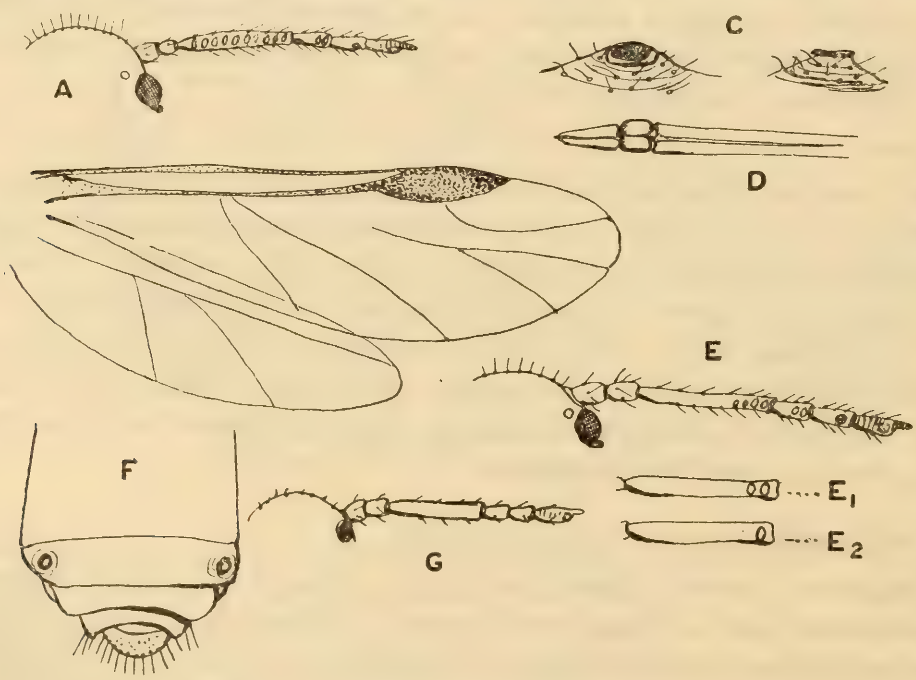

Fig. 31. *Anoecia willcocksi*, sp. n.
A, antenna of alate ♀; B, wings; C, cornicles; D, proboscis.
E, antenna of apterous ♀; E_1, E_2, variations in the sensoria;
F, end of abdomen; G, antenna of nymph.

normal. Proboscis reaching to the base of the third pair of legs, long and acuminate. Wings with brown veins and stigma; venation (fig. 31) normal. Anal plate dark, hairy. Abdomen with a few hairs and especially so between the cornicles and apex. *Length*, 2–2·5 mm.; wing expanse, 6–6·5 mm.

Apterous viviparous female.—Colour variable, majority pale green, rarely olivaceous. Head pale yellowish-green; eyes reddish. Antennae pale, slightly tinged with ochreous; sixth segment pale smoky. Thorax pale yellowish-green. Abdomen pale green, a few pale hairs on the sides and some rather longer apical ones. Legs faintly ochreous, tarsi smoky. Venter green, slightly farinose. Head rather small, slightly curved in front and hairy. Eyes large; stemmata small. Antennae not quite as long as the head and thorax; the first segment as long as the second, but a little wider; the third the longest, with 2–4 sensoria at the apex (in one specimen 4 on one antenna and 1 on the other); fourth about one-fourth the length of the third, with two sensoria on the apical half; fifth as long as the fourth with one large sub-apical sensorium; sixth longer than the fifth, with a small blunt nail with a single large sensorium at the base; all the segments with rather long hairs. Proboscis reaching to between the second and third pair of legs; apical segment dark, the penultimate wider and much shorter than the apical one. Thoracic segments all of much the same width. Abdomen with the sides parallel up to the cornicles where it bends in and terminates in a broadly based triangle; slightly hairy. Cornicles bluntly cone-shaped, with numerous hairs, dark. Cauda semicircular, dark and

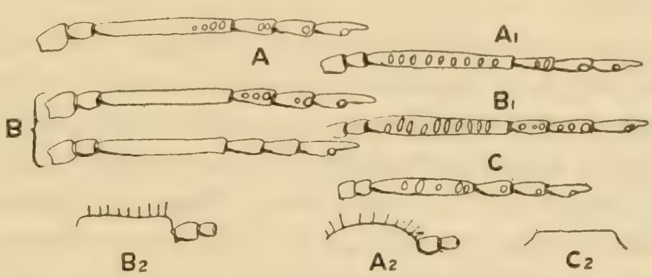

Fig. 32. *Anoecia willcocksi*, sp. n.; A, antenna of apterous ♀; A_1, antenna of alate ♀; A_2, head of alate ♀.
A. corni, L.; B, antennae of apterous ♀; B_1, antenna of alate ♀; B_2, head of alate ♀.
A. panicola, Thos. C_1, antenna; C_2, head.

hairy; sides of the last segment with a pair of prominent hairs. Legs dark brown, about equally separated, rather short and thick; tibiae and tarsi hairy. Femora of fore and mid legs rather larger than usual. *Length*, 2·5–3 mm.

Nymph.—Head obscure pale yellowish; eyes dark; ocelli red. Antennae pale, faintly tinged with ochreous, two terminal segments pale smoky. Prothorax pale orange, also mesothorax. Base of wing-buds pale ochreous, tips dusky. Abdomen greenish yellow. Legs faintly ochreous; apical part of tibia faintly smoky; tarsi dark smoky. Underside of head and thorax pale orange, venter greenish yellow.

Larva.—Pale yellowish-green; eyes reddish. Antennae with 5–6 segments, base pale, apex smoky. Legs pale, tarsi dusky.

Egypt: Gizeh, 29.iii.09 (*F. C. Willcocks*).

Food-plant. Wheat roots.

Described from several alate females, many apterous females and a few nymphae in which the wing-buds, antennae and legs seem paler, except the tarsi and apices of the antennae.

From the general body markings and shape of the alate and apterous females this insect resembles *Anoecia corni*, F., and *A.* (*Schizoneura*) *panicola*, Thos., but it clearly differs from both. From the European *corni* it differs in having sensoria on the third antennal segment in the apterous form and in generally having two on the fourth segment (not three), and one on the fifth (not two), and only the one large one at the base of the nail. In apterous *corni* I have never seen sensoria on the third segment, but in some there may be none on any segment except on the fifth and sixth. In the alatae the number of sensoria on the third is much the same, but in *willcocksi* there are two, not three, sensoria on the fourth, and on the fifth one large subapical one; whilst in *corni* there are two others. In the American *A. panicola*, the alate female, according to Hart's figure, has only five sensoria on the third segment and one only on each following segment.

This new species appears to be common on the roots of wheat in Egypt, but at present we do not know to what bush the alate females fly. As there is some variation in the sensoria in both alate and apterous forms in *corni* and the Egyptian species I might place them as one, but there is also a marked difference in the anterior form of the head; in the Egyptian species it is markedly rounded, in the European *corni* it is flat.

Amongst the colonies of green apterae Mr. Willcocks found a few specimens of darker olivaceous hue, which he describes as follows :—Head dusky grey, the greyness due to a mealy covering; eyes black; antennae with the two basal segments greyish; third with basal half pale, apical half smoky; fourth to sixth pale smoky. Prothorax olivaceous, with slightly greyish mealy covering. Meso- and meta-notum olivaceous, paler at the sides and between the segments. Abdomen olivaceous above, greenish laterally, highly polished; two apical bands of olivaceous green; numerous pale hairs along lateral margins and apex. Venter pale green, slightly farinose; hairs pale, most numerous on apex. Anal plate dusky. Spiracles surrounded by dark areas. Legs smoky, femora pale at base, tarsi dark. One specimen was quite dusky all over the dorsum and the sides green; they were not shiny, but otherwise resembled the type described, except that the olivaceous areas are replaced by a dusky hue.

Lachnus viminalis, Boyer.

Aphis viminalis, Boyer.
Aphis saligna, Sulzer, Walker.
Aphis salicina, Zett.
Aphis salicis, Curtis.
Lachnus dentatus, Le Baron ?

Boyer de Fonscolombe, Ann. Soc. Ent. Fr., x, p. 184 (1841); Sulzer, Ins., pl. ii, fig. 6 (1761); Walker, List Homop. (B.M.), pt. iv, p. 959 (1852); Zetterstedt, Ins. Lapp., i, p. 311 (1840); Curtis, Trans. Linn. Soc., vi, p. 75, pl. v., figs. 1 and 2 (1800); Passerini, Aphid. Ital., p. 64 (1863); Ferrari, Aphid. Liguriae, p. 80 (1872); Buckton, Mono. Aphid. Brit., iii, p. 53, pl. xcix (1880); Muller, Eastbourne Nat. Hist. Soc., pp. 1–6 (1881); Theobald, First Rept. Econ. Zool. Brit. Mus., p. 116 (1903); Theobald, Journ. S.E. Agric. Coll., no. 14, pp. 126–132, fig. 36 (1905); Schouteden, Mém. Soc. Ent. Belg., xii, p. 207 (1906); Theobald, Rept. Econ. Zool. for 1912, pp. 96–98 (1913).

EGYPT: Salka, xi. 12 (*F. C. Willcocks*).

Food-plant. Willow (*Salix* sp.).

This large *Lachnus* agrees in all the essential characters with *L. viminalis*, which I have found in abundance in Britain and in parts of France, and I have no doubt whatever that it is the same species. It has been recorded from France, Norway, Italy and Belgium, and probably occurs all over Europe. Sulzer (1761) undoubtedly refers to this species, and Curtis (1800) described and figured this insect as an *Aphis* on willows.

This large species can at once be told by the curious horn-like process on the dorsum of the abdomen. Numerous interesting papers and notes have been written on it, the chief of which have been mentioned here. It undoubtedly has considerable economic importance in osier cultivation on account of the damage it now and then does, and its occurrence in vast colonies at certain times has given rise in the past to speculation as to its possible value as a sugar and dye producer; needless to say, it is of no commercial value.

Genus PROTOLACHNUS, nov.

Head large; eyes very prominent; the two stemmata of the alate female raised up and in front of the eyes; antennae thin, shorter than the body. Proboscis long, blunt, the last two segments short and equal. Body narrow and rather long. Cornicles circular, nearly flat. Legs long, especially the hind pair, femora and tibiae hairy, especially the hind tibiae; both tarsal segments long; coxae of the hind legs very large, especially in the alate female. Head with very long hairs, also the body, the hairs arising from prominent tubercles. Wings narrow, the first vein not arising from the subcostal and only once forked, very indistinct.

Fig. 33. Anterior wing of *Protolachnus tuberculostemmata*, sp. n.

The chief characters of this genus are the tuberculate stemmata in the alate female, blunt proboscis, greatly enlarged hind coxae and the wing venation.

Protolachnus tuberculostemmata, sp. nov. (figs. 33, 34).

Alate viviparous female.—Body very flat, green; thoracic lobes dark; antennae, ends of tibiae and tarsi brown. Head large, brownish ochreous, with four large slightly capitate hairs in front and two rows of four on the vertex, arising from tubercles; eyes large, projecting, black; stemmata in front of the eyes, pale, placed on a dark projecting area, having a tuberculate appearance. Antennae of six segments, shorter than the body, thin; first and second of the same colour as the head; third pale at base, the rest dusky; basal segment slightly wider than the second and of about the same length; the third the longest; the fourth half the length of the third and shorter than the fifth, both with a subapical sensorium, that on the fifth oval; sixth shorter than the fifth, with short blunt nail and two sensoria,

the apical one elongate; all the segments with a few short hairs and imbricated. Pronotum of the same colour as the head, farinose at side; thoracic lobes dusky and mealy. Proboscis reaching to third coxae, blunt, the last two segments rather small and equal; pale, tip black. Abdomen pale grass-green, speckled with black spots and with faint transverse bands; narrow, with rows of hairs coming from the darkened tubercles; cauda and anal plate pale, with rather long hairs. Legs pale; greenish femora, with dusky yellow tibiae, apices darkened; fore and mid pairs moderately long; coxae normal; hind pair very long, coxae large and thick, projecting well away from the body; tibiae very long and thin; tarsi dark, long, first segment half the length of the second; femora with short hairs; tibiae with long, thick, spine-like hairs on one side, smaller ones on the other and over the

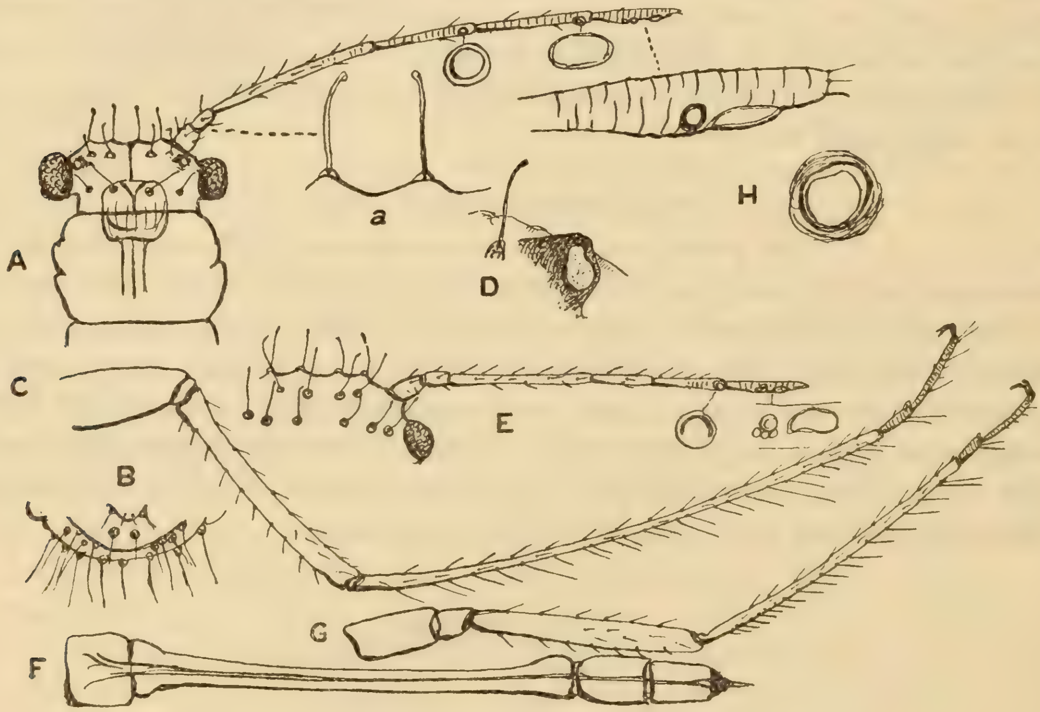

Fig 34. *Protolachnus tuberculostemmata*, sp. n.; A, head, pronotum and antenna of alate ♀; (*a*) frontal hairs; B, cauda and anal plate; C, hind leg; D, lateral stemmata. E, head and antenna of apterous ♀; F, proboscis; G, hind leg; H, cornicle.

whole surface; a pair of long apical hairs on the basal tarsal segment and smaller ones on the other side and moderately long ones on the second segment. Wings with delicate stigma and veins, faintly greenish. *Length*, 1·5 mm.; wing expanse, 3·5 mm.

Apterous viviparous female.—Narrow; green to yellowish green, bearing dusky tubercles from which arise short stiff black hairs. Head nearly as wide as the thorax, adorned with hairs as in the alate female; eyes large, black, prominent. Antennae about half the length of the body, brown, paler at the base; basal segment very little wider than the second, of the same length; third segment the longest; fourth about half as long as the third; fifth a little longer than the fourth, with a large sub-apical sensorium; sixth shorter than the fifth, with a short blunt nail, one large sensorium on it and a group of smaller ones below; all the segments with a few moderately long stiff hairs; dusky, except the two basal segments, which are greenish;

basal area of third segment pale. Proboscis long, reaching past the third coxae; of similar shape to that of the alate female. Body pale green, with rows of stiff hairs arising from round dark tubercles. Cauda and anal plate pale, both semicircular, with long pale hairs. Legs pale yellowish-green or greenish ochreous, with dusky tips to the tibiae and dusky tarsi; fore and mid pairs moderately long; hind pairs very long, not so long as in the alate female, but well projecting from the body; femora with stiff hairs; tibiae with long dark spine-like hairs on one side, shorter ones on the other and over the surface; tarsal hairs similar to those on alate female. Cornicles round, only slightly raised above the surface. *Length*, 1–1·5 mm.

Larva.—Body yellowish green with dusky spots; eyes black. First segment of antennae pale, the rest pale smoky. Legs with pale femora, smoky tibiae and tarsi. Proboscis reaching well beyond the third coxae.

Egypt: Gizeh, 22.vi.09 (*F. C. Willcocks*).

Food-plant. Pinus sp. (? Aleppo Pine).

Described from a single alate female and many apterae and Mr. Willcocks' colour notes from living specimens. It is a very marked species, which I cannot place in any described Lachnid genus, owing to its long, blunt proboscis, greatly enlarged hind coxae and wing venation. It feeds on the needles of a pine, which Mr. Willcocks says may be the Aleppo pine. It is a shy insect and can run in a very active manner. Types in the writer's collection.

Pemphigus globulosus, sp. nov. (figs. 35, 36).

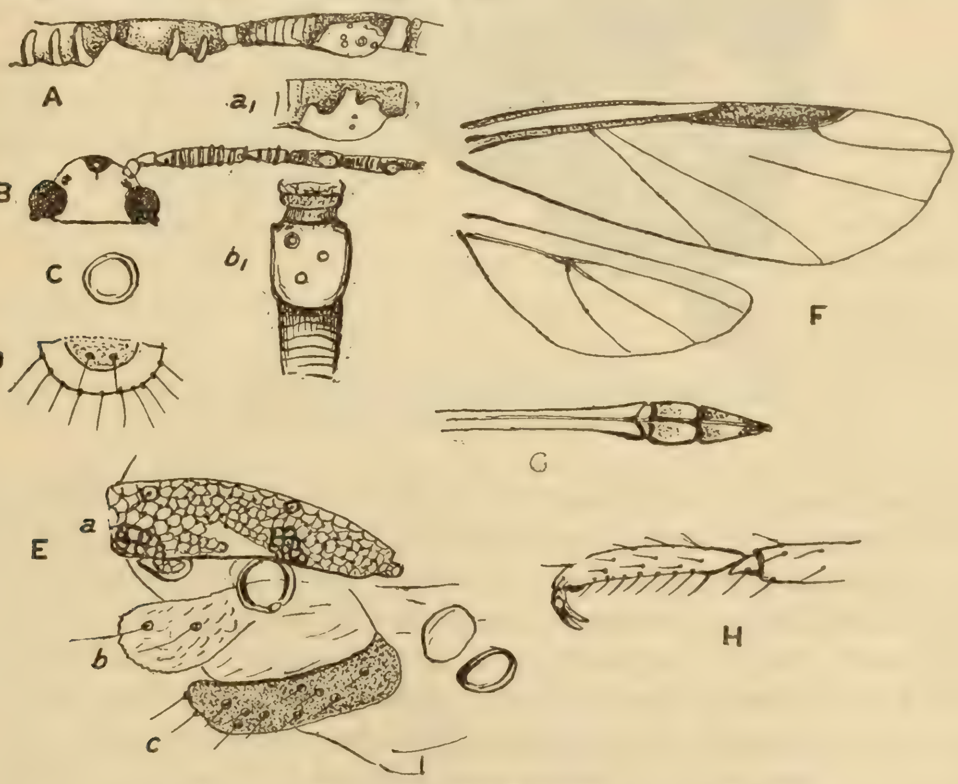

Fig. 35. *Pemphigus globulosus*, sp. n., alate ♀; A, 4th and 5th segments of antenna; A (*a*), further enlarged sensoria; B, head and antenna; B (*b*), sensoria of 5th segment; C, cornicle; D, cauda and anal plate; E, side view of (*a*) supra-anal plate; (*b*) cauda; (*c*) anal plate. F, wings; G, proboscis; H, hind tarsus.

Alate viviparous female.—Head dull black, mealy; secretion white or somewhat bluish white, imparting to the head more of a bluish black than dead black colour; eyes black. Antennae smoky black; second segment pale at base; pale at the joints. Pronotum of an obscure apricot colour and farinose, with a dark farinose ring. Mesothorax dull black, slightly polished in some examples; on account of the mealy covering the black appears as a blue-black rather than true black. Abdomen of a dull apricot colour and farinose, the mealiness being in zones, conforming more or less with the segmentation of the abdomen; junctures of segments not mealy or only slightly so; the farinose matter very abundant and conspicuous at the apex of the abdomen. Venter apricot and farinose, junctures of segments not mealy. Underside of prothorax apricot. Sternal plates brown to black. Legs smoky or smoky-black. Wings with dusky insertions; costa dusky or very pale smoky;

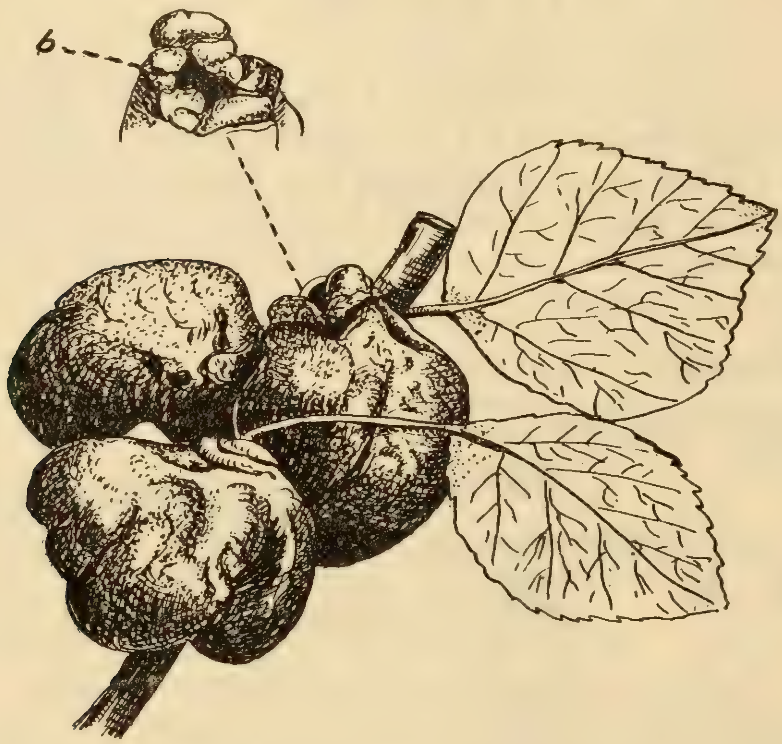

Fig. 36. Gall of *Pemphigus globulosus*, sp. n.
(*b*) opening of gall. (nat. size).

cubitus dark; stigma yellowish, with dark brown margin; obliques ochreous. Antennae about as long as the head and thorax, of six segments; the basal one of about the same size as the second; the third the longest, with 7–9 annulations; the fourth about half the length of the third, with 3 annulations; the fifth longer than the fourth, with a very large apical sensorium, base of the segment striated; the sixth a little shorter than the third, with a very small blunt nail and a large sensorium at its base, the rest striated, with a few short hairs at the apex. Frons rounded; eyes very large; median stemmata on a dark area. Proboscis short, not reaching the second coxae; apical segment a little longer and narrower than the penultimate. Cauda and anal plate rounded, the former small, with two hairs; the latter darkened at the apex, with many hairs. Cornicles small, flat, circular. Legs normal; tibiae with short hairs. *Length,* 2–2·5 mm.

Larva (at birth).—Colour orange; eyes dark. Legs and antennae very pale smoky. *Length*, 0·6 mm.

Nymph.—Pale yellow, rather a lemon yellow or slightly primrose; apex of abdomen with a tuft of white flocculent secretion. Head rather an obscure yellow, primrose. Eyes black, a prominent dusky spot on the eyes. Antennae pale. Thorax clear primrose yellow. Wing-buds yellow, of a slightly paler hue than the thorax, tips faintly shaded. Abdomen clear primrose yellow; a mass of white flocculent matter at the apex. Legs ochreous or an obscure yellowish smoky hue, sparsely covered with meal.

Egypt: Near Tanta, Cairo and Mansourah, 16.v.1909 (*F. C. Willcocks*).

Food-plants. Poplar (*Populus* sp.).

Described from a number of alate females sent me by Mr. Willcocks and his colour notes from living specimens. The galls which I have figured (fig. 36) are very marked, being large irregular globular masses; in the specimen sent me three are united together. They somewhat resemble in form those of Tullgren's *Pemphigus lichtensteini*, but are formed by a clearly distinct species, as the fifth antennal segment has a very marked large sensorium, quite unlike that in Tullgren's figure (Arkiv. für Zoologi, v, p. 150, fig. 71a, 1909).

Tychea phaseoli, Pass. (fig. 37).

Passerini, Gli Afidi, p. 39 (1860) and Aphid. Ital., p. 81 (1863); Buckton, Mono. Brit. Aph., iii, p. 90, pl. cxxviii (1882).

Alate viviparous female.—Head black, dull; hairs pale; eyes black. Antennae with segments 1, 2 and 3 black, 4, 5 and 6 paler, smoky in hue; the posterior part of the head may be an obscure greyish-green. Pronotum with anterior edge dark, darker still at sides; posterior portion obscure greyish-green; meso- and metanotum black. Abdomen dull brownish-orange with a median longitudinal irregular brown area, extending from the third segment to the apex. This brown area is not regular, and shades into brown specks at the margins; posterior margins of basal segments distinctly green; apex dark; anal plate black; venter more or less obscure orange, slightly farinose, the mealy matter white; sternal plate black. Proboscis reaching the second coxae, the two apical segments black, base black, pale in middle. Legs: front pair black, hairs pale; median and posterior pairs also black, except apices of femora which are grey. Wings with dark smoky costa, blackish cubitus and smoky stigma; veins smoky; insertions of wings pale; in the second pair the cubitus is ochreous and the obliques pale; wings iridescent in some lights. When mounted in balsam the abdomen shows darker transverse bars behind and five small dark spots on each side. Antennae shorter than head and thorax, of six segments; basal one small, second more than twice as long, rounded at apex; third small, but slightly longer than the sixth, with eight sensoria, four large, the others smaller; fourth segment about as long as the fifth and as long as the second, with 2–3 sensoria near the apex; fifth with a single large subapical sensorium; sixth with a short blunt nail and sensorium at its base; all the segments with fine, rather long hairs. Cauda small, semicircular, with short fine hairs; anal plate with longer hairs. Mid pair of legs nearer to the hind than to the fore pair; hind tibiae slightly curved

outwards ; tibiae and tarsi with numerous thin hairs, one large one at apex of femora ; claws double on all legs. *Length,* 2·0–2·5 mm. ; wing expanse, 8 mm.

Apterous viviparous female.—Globose ; bright yellowish-buff to almost white, covered with white meal, sometimes scanty, at others sufficiently thick to give the insect a white miller-like appearance. Head hairy, brownish, mealy ; eyes black, very small. Antennae with first to fourth segments ochreous, fifth and sixth smoky, or sixth only smoky. Thorax and abdomen uniform yellowish-buff to white ; numerous pale hairs on the body. Venter of same colour as dorsum, mealy. Legs ochreous to pale ochreous brown, knees slightly darker. Antennae shorter than head and thorax, of five segments, the first a little smaller than the second ; the third about as long as or slightly longer than the fifth ; fourth small, about half the length of the fifth, with a single subapical sensorium ; fifth with a very small

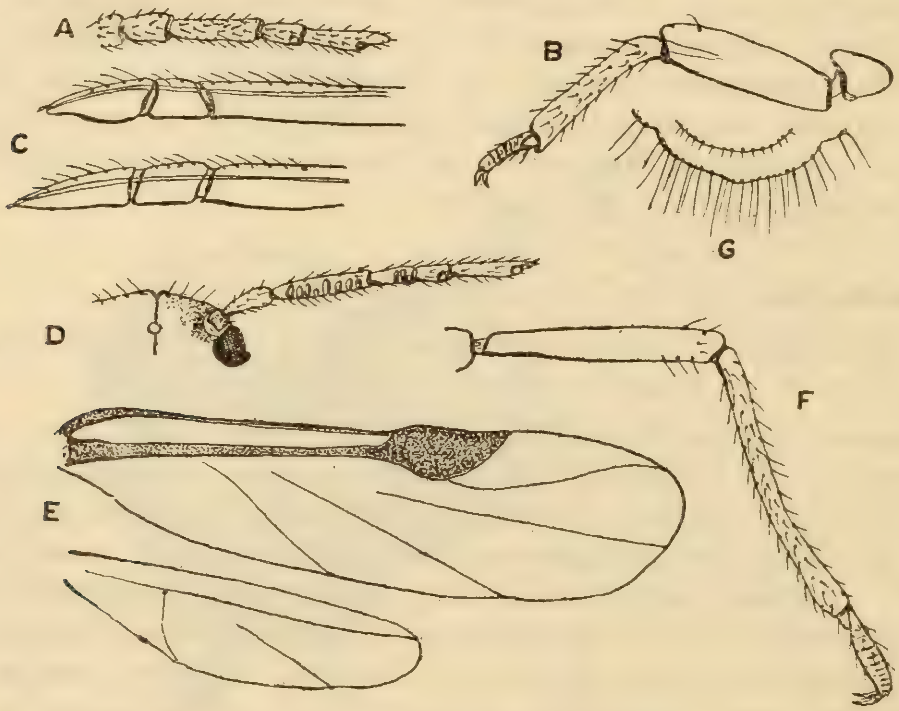

Fig. 37. *Tychea phaseoli,* Pass. ;
A, antenna of apterous ♀ ; B, fore leg ; C, proboscis. D, antenna of alate ♀ ; E, wings ; F, hind leg ; G, cauda.

blunt nail ; all the segments hairy. Proboscis pale, with dusky apex, reaching just beyond the second or to the third coxae ; acuminate, apical segment longer and slightly narrower than the penultimate, with numerous hairs. Legs rather short and thick, the fore femora and tibiae nearly equal ; in the hind legs, the tibiae slightly the longer ; mid pair a little nearer to the hind than to the front pair ; femora, tibiae and tarsi hairy. Apex of body densely hairy. *Length,* 1·5–2·5 mm.

Larva.—First stage bright orange ; eyes black. Antennae and legs colourless, very glassy in appearance, hairs quite pale. Coxae orange. Proboscis with apical half colourless, basal half orange. Second stage bright orange. Head dusky, with very fine median line, halving the dusky area, which does not extend over the entire upper part of head ; at the sides, around eyes and base of antennae the head is orange. The dusky area extends back to the pronotum, which has two lateral dusky

areas, all three, however, paler than the large central dusky area of the head. Eyes very small and black. Antennae pale, sixth segment pale smoky. Thorax and abdomen hairy, bright orange. Venter orange. Proboscis reaching well beyond third coxae, dark at apex, pale medianly, dusky at base. Legs pale, including tarsi; claws dark.

EGYPT: Ghezireh, 30.iv.09 and 5.v.08 (*F. C. Willcocks*). Occurring also in Italy, France, and Britain.

Food-plants. Bean roots, including French beans (*Phaseolus vulgaris*), broad beans (*Fabia*) and scarlet runners (*Phaseolus coccineus*); also *Brassica*, *Euphorbia* and *Amaranthus*.

The apterae from Egypt agree exactly with European specimens. The alate female of this species does not appear to have been described before. It is very marked both in antennal structure and wing venation (fig. 37). Willcocks sends a note saying that it occurs in very large colonies on bean roots in the Laboratory gardens, and that the alate females are produced in numbers. The young when born are quiescent, the limbs not being free, but only remain in that condition a very short time, soon becoming very active.

Rhizobius ?graminis, Buckton (fig. 38).

Buckton, Mono. Brit. Aph., iv, p. 93, pl. cxxix, figs. 9–14 (1882).

Alate viviparous female.—Head, antennae, thoracic lobes and legs black, the rest of the body olivaceous green, yellowish green or dull yellowish green, median dorsal area dusky grey. Head small, narrow in front, slightly indented in the middle; eyes large and black. Antennae not as long as the head and thorax, of six segments, with pale bands between the black segments; first small, irregular, broader than the second, which is semiglobular; the third slightly longer and narrower, constricted at the base, with one large apical sensorium; the fourth of the same length as or slightly shorter than the third, of similar form and with a large apical sensorium; the fifth a little longer and rather narrower than the fourth, narrowed at the base, with a single large apical sensorium; sixth the longest, with a short blunt nail and an elongate large sensorium. Proboscis short, thick, reaching nearly to or just past the first pair of legs. Wings iridescent, with yellowish green insertions and dusky costa; ochreous stigma, margin bottle-green; veins pale smoky, with smoky pigment outlining them; longer than the body; venation marked (fig. 38). Legs rather short and with small scanty hairs on the tibiae, a few on the apex of the femora and one on the tarsus; ungues double on each leg. Cauda dusky, small, the anal plate projecting beneath, with rather long hairs. Body nude. Venter ochreous green, slightly farinose laterally; prosternum smoky green; sternal plate black. *Length*, 1·8–2 mm.

Apterous viviparous female.—Entirely pale creamy white, pale buff or dull yellowish, except the legs, antennae and head, which are smoky; elongate oval. Head small, rounded in front. Antennae farinose, brown to smoky; very short, of five segments; the first four nearly equal in length; the first and second broader than the third and fourth; the fifth the longest, as long as the third and fourth and thinner, with a short blunt nail; a single large sensorium at the apex of the fourth and two at the base of the nail of the fifth. Proboscis short and thick, the three segments nearly

equal in length, reaching to the coxae of the second pair of legs. Legs very short and thick, the tibiae a little shorter than the femora, equidistant apart ; claws double on each leg, no hairs visible. There are traces of darkness on the head of varied form in balsam preparations (but no rows of dark spots down the abdomen) and thin hairs. Cauda dusky, slightly hairy. *Length,* 1·8–2 mm.

EGYPT : Gizeh, 30.iii.09 (*F. C. Willcocks*). Also in Europe.

Food-plants. Wheat and various grass roots.

The structure of the apterous Egyptian specimens agrees with Buckton's *Rhizobius graminis,* which he described first as *Rhizobius poae.* The apterae do not show the black spots referred to by Buckton nor does Mr. Willcocks refer to them ; but as the structure agrees exactly I feel sure the Egyptian species is the same as the European. Nevertheless I place it with a query. Alate *Rhizobius* have not so far been described, so that the winged viviparous female detailed here is the type of that genus.

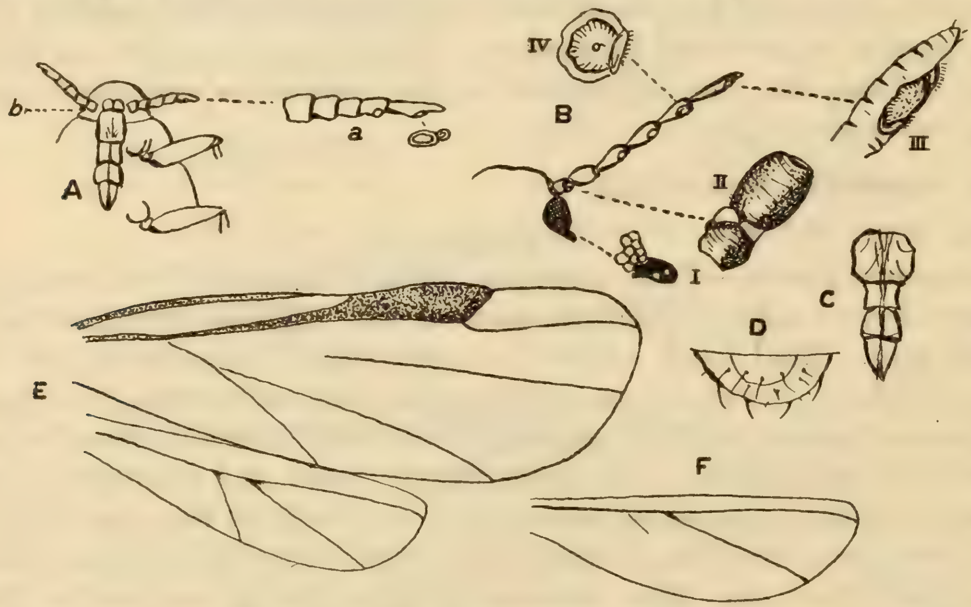

Fig. 38. *Rhizobius graminus,* Buckt.;
A, under surface of head of apterous ♀; *a, b,* antenna.
B, head and antenna of alate ♀; (I) ocellar process ; (II) basal antennal segments ; (III) apex of 6th segment ; (IV) sensorium on 5th ; C, proboscis ; D, cauda and anal plate ; E, wings ; F, abnormal lower wing.

Some of the specimens sent by Mr. Willcocks came from grass roots along a canal bank at Gizeh, the others from the roots of wheat.

Buckton describes the apterous female as " dull ochreous yellow. Eyes, antennae, legs and 2 occipital longitudinal bands, brown. Abdomen deeply ringed with numerous dark spots, ranged in transverse rows across the dorsum. A pale line passes from the vertex down the whole back." Buckton refers to the front tarsi as having a single claw, evidently in error. Willcocks describes the nymph as " yellow, wing-buds pale, eyes and ocelli red. Legs and antennae very pale smoky."

The females, larvae and pupae produce long filaments of a bluish-white secretion, like wool, from pores on the dorsum.

A second species seems to have been found by Willcocks in which the body is very globose and covered with numerous short hairs, farinose and buff in colour, and possibly a third species, but I am unable to isolate these.

New Localities and Food-plants.

Macrosiphum rosae, L.

Bull. Ent. Res., iv, p. 333, fig. 14 (1914).

EGYPT: Gizeh, 1907 and 1909, on roses, and Ghezireh, 25.iii.09 (red and green forms) (*F. C. Willcocks*).

Rhopalosiphum dianthi, Schrank.

Bull. Ent. Res., iv, p. 320 (1914).

EGYPT: Gizeh, 27.iii.13, on potato; 19.ii.10, on peach; iii.10, on apricot (*F. C. Willcocks*). TRANSVAAL: Onderstepoort, 28.vii.14, on tobacco (*G. Bedford*).

Aphis gossypii, Glover.

Bull. Ent. Res., iv, p. 321, fig. 5 (1914).

EGYPT: Gizeh, 19.xii.12, on maize.

Mr. Willcocks sent me slides of what apparently looked like two cotton aphids, one of which he called the large cotton aphis, the other the small cotton aphis, these having been taken together. On examining them I find they agree exactly in structure and there is no doubt they are both *Aphis gossypii*, Glover. The smallest alate females were only 1 mm. long, the largest 2·0 mm.

Aphis tavaresi, Del Guercio.

Bull. Ent. Res., iv, p. 323, fig. 6 (1914).

BRITISH EAST AFRICA: Kabete, 5.i.11, on Jamaican lime (*T. J. Anderson*).

The wings of the alate viviparous females are tinged with brown. This species gives a deep port-wine colour to alcohol.

Aphis rumicis, L.

Bull. Ent. Res., iv, p. 329 (1914).

EGYPT: Ghezireh and Marg, 31.iii.09 and 10.iv.09, on docks (*Rumex* sp.) and poppies (*Papaver*).—(*F. C. Willcocks*).

Aphis (Myzus) nerii, Boyer.

Bull. Ent. Res., iv, p. 329 (1914).

TRANSVAAL: Pretoria, 3.iv.14, on oleander (*Nerium oleander*).

Toxoptera graminum, Rondani.

Bull. Ent. Res., iv, p. 333, fig. 14 (1914).

EGYPT: Gizeh, on wheat (*F. C. Willcocks*).

Willcocks gives the colour as dark green, which does not agree with the usual colour, but I cannot separate his examples from the European and American specimens which I have.

THE SYNONYMY OF ANOPHELES CHRISTOPHERSI, THEO., AND A. INDEFINITA, LUDL.

By C. S. Ludlow,

Army Medical Museum, Washington, D.C.

For some time an Anopheline found in the eastern tropics has been accumulating names in a most unfortunate way, and as the mosquito has proven to be a very active carrier of malaria, and I myself am partly to blame for this multiplication of names, it seems fit that I should try to untangle the synonymy.

When the study of Philippine mosquitos was in its infancy, there was sent in to me an Anopheline which, according to the only authority available at the time,* seemed to be *Anopheles funestus*, Giles. This Anopheline is common in the Islands and was early seen to be so usually collected in connection with the report of malaria that in 1908† I recorded that it " is taken always when malaria is present or prevalent," and this was so conspicuous that I stated " one specimen in a collection is enough to lead to a suspicion that malaria is present, and even a small number of them is usually accompanied or immediately followed by new cases, the number (of cases) depending largely on the prophylactic control of the station."

Nothing occurred to suggest to me that an error had been made in referring this species to *A. funestus* until the spring of 1912, when in discussing some Philippine mosquitos with Dr. Malcolm Watson, Chief Medical Officer, Estate Hospital Association, Klang, F.M.S., who was in Washington at that time, he called my attention to the fact that the dark species under consideration had a light ventral apical portion on the proboscis, and it seemed possible that it was an undescribed species. I gave Dr. Watson specimens of various Philippine mosquitos which he took to Mr. F. W. Edwards (British Museum) for confirmation of my naming, and at once wrote me that what I had called *funestus*, Giles, was really *christophersi*, Theo. In the meantime I had published a description of the dark specimens as *Myzomyia flavirostris*.

Mr. Edwards also kindly wrote me in regard to the matter, saying there could be no doubt as to the naming of the species, especially as Mr. Theobald's types in the British Museum were " fortunately in good condition. The type of *christophersi* has two broad apical palpal bands like your *funesta*. On the other hand both *funesta*, Giles, and *listoni*, Liston, have female palpi with three narrow bands," and in a later letter with reference to specimens I had sent him, Mr. Edwards writes : " Your *M. funesta*, Giles," and " *M. flavirostris*, Ludl., both, as you suggest, = *christophersi*."

In preparing the MS. of " Bulletin No. 4, Surgeon-General's Office," in 1913, as this species had heretofore been reported to the Medical Corps, U.S. Army, as " *M. funesta*," it seemed wise to retain the name and Giles' description and add a foot-

* Giles, G. M.—Gnats or Mosquitos. 1st Edition.

† Ludlow, C. S.—Mosquitos of the Philippine Islands, the distribution of certain species, and their occurrence in relation to certain diseases, 1908.

note explaining the error which had occurred, giving the correct name and synonymy, which, with the description of *flavirostris* immediately following, it was believed would make the matter quite clear.

It was therefore a surprise to find Mr. Banks had redescribed this species as *A. febrifer** and that Messrs. Walker and Barber in their article "Malaria in the Philippines" had referred to its connection with malaria as if that were quite unknown.† The foot-note at the end of this article is also definitely misleading, as I did not suggest that *christophersi* = *listoni*, but showed that, whatever else the synonymy might be, it did not include *listoni*.

Dr. Marshal A. Barber sent me specimens of this mosquito for determination which reached me in beautiful condition, and there can be no doubt that it is the one I had wrongly referred to "*funesta*," that is, it is unquestionably *christophersi*.

The synonymy of this species as given by Mr. Edwards‡ and added to by myself and Mr. Banks is therefore :—

Anopheles (*Myzomyia*) *christophersi*, Theobald.
= *alboapicalis*, Theobald.
= *mangyana*, Banks.
= *funesta*, Ludlow (*non* Giles).
= *flavirostris*, Ludlow.
= *febrifer*, Banks.

The re-naming of this species by Banks is the more interesting because of the extreme amount of malaria among the Mangyans and that *Myzomyia mangyana*, Banks, was described in connection with a recognition of that condition.

In regard to *Anopheles rossi*, Giles, as used by Banks, it includes at least three forms :—

Myzomyia ludlowi, Theo.
Myzomyia indefinita, Ludl.
Myzomyia parangensis, Ludl.

and is therefore nearly as confusing in the reduction of names as is the multiplication of names in the species previously considered. It is easy to collect data concerning the relationship of these species, which have probably been more or less mis-comprehended. Mr. Edwards writes me, in regard to specimens I had sent him marked "*M. rossii* or *indefinita* ?" : "I think I mentioned to you my conclusions

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* Banks, C. S.—"A new Philippine Malaria Mosquito," Phil. Journ. Sc., ix, Sec. D, no. 4, Aug. 1914.

† Walker, E. L., and Barber, M. A.—"Malaria in the Philippines." Phil. Journ. Sc., ix, Sec. B, no. 5, Sept. 1914.

‡ [Mr. F. W. Edwards has kindly supplied the following note on this species :—"Since publishing my views on the synonymy of this species (Bull. Ent. Res., iv, p. 222) I have come to the conclusion that the oldest name for it is *A. minimus*, Theo. It is very common at Hong-Kong, and there is no other Hong-Kong species which answers at all to Theobald's description. The name *christophersi* must therefore be dropped ; this is fortunate as it will avoid any confusion with *listoni*. The Malayan *A. aconitus*, Dön. (= *albirostris*, Theo.) is probably a geographical form of *A. minimus*, differing only in having the apical half of the proboscis pale on the upper as well as on the under side. This difference however appears to be constant."—Ed.]

on this subject, but am not sure. They are that *indefinita* is a variety of *rossi* representing it in the Philippines and Malaya, the true *rossi* not occuring further east than India and Ceylon.* These specimens, like all I have seen from the Philippines, are *indefinita*."

Christophers† says that though *Nsm. ludlowi* rather closely resembles *Nsm. rossi* the "eggs of the two species are quite distinct," and Strickland‡, while not agreeing with Christophers on this point, after having given the differences in the two larvae, says, "The larva of *ludlowi* is therefore quite distinct from that of *rossi*§" and in a foot-note adds: "As a certain amount of confirmation, we may note that if either *ludlowi* or *rossi* had hatched out of one of our breeding bottles, on examining the larvae remaining in the bottles we found in *every* case, although we need not have expected such favourable evidence, that they were of the type which we now ascribe to the respective species."

The description of *Myzomyia parangensis* has been comparatively lately published, but specimens were sent to Edwards for comparison before its publication and his verdict was "This is quite unlike any Anopheline I have seen before. I suppose it comes nearest to *ludlowi*."

The *status* of these species seems to be that the Anophelines taken in the Philippines which closely resemble *rossi* are *indefinita*, and that *ludlowi* and *parangensis* are established species.

When insects are connected with the transmission of disease it is doubly important that the nomenclature should be as unclouded as possible, and it is hoped that the above points may clear some of the confusion which has existed concerning these species.

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* [Concerning this point Mr. Edwards now says :—"This view cannot be strictly maintained. I have recently examined specimens of the true *A. rossi* from the Philippines, and of the var. *indefinitus* from Pusa, Bengal. The latter is chiefly distinguished by the much broader white band at the tip of the female palpi."—Ed.]

† Christophers, S. R.—"Malaria in the Andamans," Sci. Mem. by Off. of Med. and San. Depts. Govt. of India (New Series), No. 56.

‡ Strickland, C.—"The comparative Morphology of the Anophelines *Nyssomyzomyia ludlowi*, Theob., and *Nyssomyzomyia rossi*, Giles," Bull. Ent. Research, v, pt. 4, March 1915.

§ [Mr. Strickland has recently written to say that the insect called by him *Nyssomyzomyia rossi*, Giles, in the paper referred to, is undoubtedly *N. rossi* var. *indefinita*, Ludl.—Ed.]

THE LARVAE OF MALAYAN ANOPHELES.

By A. T. Stanton,

Institute for Medical Research, Kuala Lumpur, Federated Malay States.

Introductory.

It was long ago recognised by students of the biology of mosquitos that differences in certain larval characters could be employed for the separation of the Culicidae into groups and even for the recognition of individual species. Present-day knowledge of this subject in relation to the Anopheline group is largely based on the work of Grassi in Italy and James and Christophers in India.

It has been stated that in Anopheline larvae the characters are not sufficiently constant to be reliable for the identification of species. Recent studies have shown, however, that those differences which were formerly believed to be variations in the

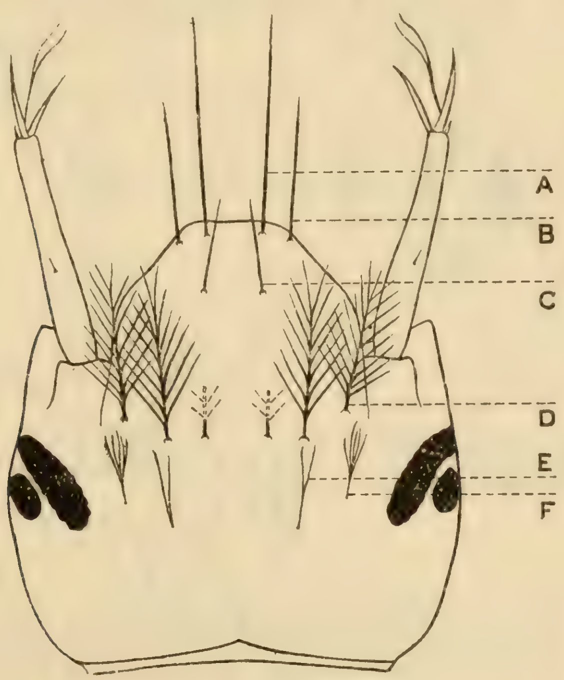

Fig. 1. Diagram to show position of hairs on dorsal surface of the head of an *Anopheles* larva (for explanation see text).

larva of a single species, are in reality changes of a constant kind associated with successive phases of its growth and that there is a high degree of constancy in the specific characters of larvae at identical stages of growth. In the examination of many thousands of Anopheline larvae taken in the Malay Peninsula and neighbouring islands, it has been possible to recognise with certainty the larvae of most of the species found in this region. A certain assemblage of characters is diagnostic of the species.

The characters which have been found useful for the identification of species are the form and relative position of certain appendages of the cuticle, hairs and similar structures, designed to subserve functions of sensation and the maintenance of

position at the water surface for breathing and feeding. The accompanying diagram (fig. 1) shows the position of these appendages on the upper or dorsal surface of the head in an *Anopheles.* A and B are the inner and outer pairs of *anterior clypeal hairs,* C the pair of *posterior clypeal hairs*; these hairs differ notably in form and position in different species and in the same species at different stages of its growth. D is one of a row of six *frontal* hairs between the bases of the antennae, E and F are the inner and outer pairs of *occipital* hairs; in a few species only are these groups of value for identification. There is also present in certain species a branched hair on the shaft of the antenna.

It is not only in *Anopheles* that the form and arrangement of the hairs on the dorsum of the larval head are characteristic; in other groups of CULICIDAE they are also of generic and specific value. In Malayan species of the Culicine genus

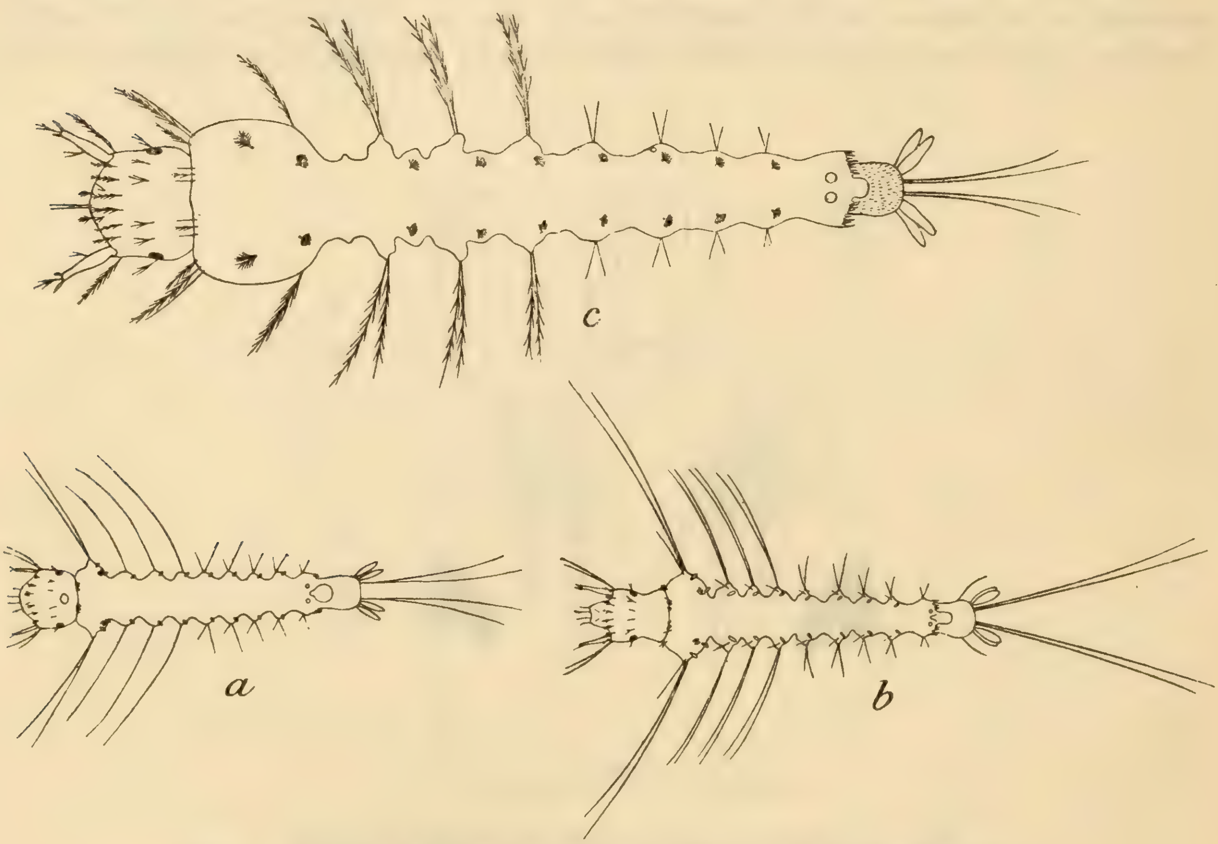

Fig. 2. Larva of *Anopheles sinensis,* Wied.; *a,* newly hatched; *b,* after first moult; *c,* after second moult.

Stegomyia and of the nearly related genera *Armigeres, Ochlerotatus* and *Danielsia,* the general arrangement of larval head hairs is the same, while their form differs in the different species. Larvae of the genus *Uranotaenia* are characterised by the presence of large spinous setae on the dorsum of the head.

Growth Changes in Anopheline Larvae.

During the growth of Anopheline larvae of all species notable changes take place in the form and arrangement of the clypeal hairs of the head and in the leaflets of the thorax and abdomen. Drawings of the larvae of *Anopheles sinensis,* Wied., at different

stages in its growth (fig. 2) show the details of these changes in that species. Thus in the early stages the anterior and posterior clypeal hairs are simple, in the later stages the outer anterior clypeal hair is thickly branched, the inner one being simple, and the posterior clypeal hair is slightly branched. It will be observed too that the relative positions of the anterior clypeal hairs also differ, the middle pair being much closer together in the later stages.

In the earlier stages of most Anopheline larvae leaflets varying in number and position are present on the dorsal surface of the thorax and segments of the abdomen. In later stages these are transformed, on the thorax some to plumose or branched hairs and some to stellate tufts, on the abdomen to stellate tufts only. The form of the leaflets in the stellate tufts of mature larvae is of diagnostic value, as is also the number of such stellate tufts borne by the larva. Two groups of three hairs situated on the front edge of the thorax, the sub-median anterior thoracic hairs (fig. 3, *b*, A), are also of value in the separation of certain species. In the early stages of Anopheline larvae these hairs are represented by leaflets, their form in the later stages of *A. barbirostris* and *A. sinensis* is shown in fig. 3.

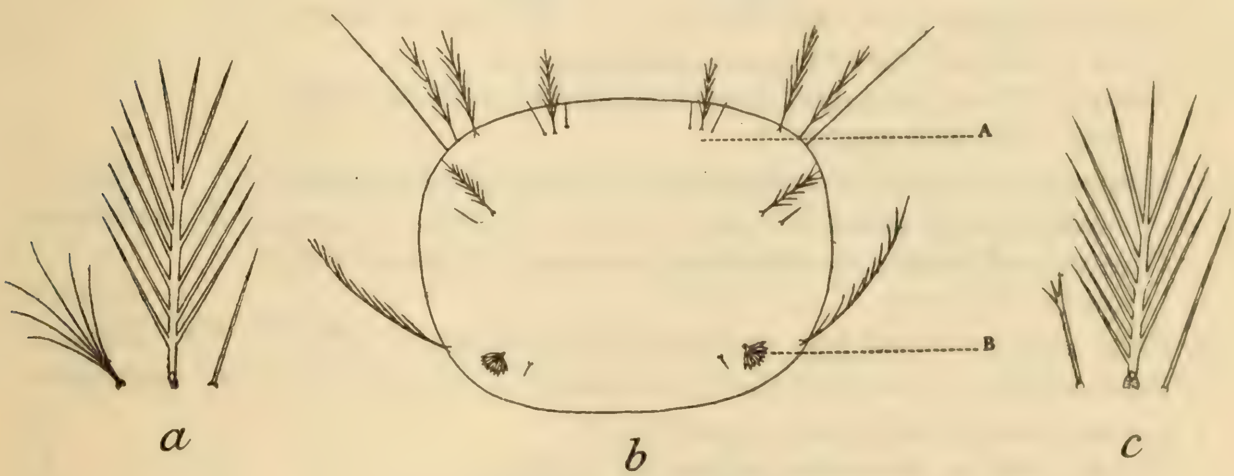

Fig. 3. Thoracic hairs of Anopheline larvae; *a*, sub-median anterior thoracic hairs of *A. barbirostris*; *b*, diagram to show position of hairs on the thorax of an *Anopheles* larva; (A) sub-median anterior hairs; *c*, sub-median anterior thoracic hairs of *A. sinensis*.

In previous papers (1912, 1913, 1914) I have described the mature larvae of a number of Malayan Anophelines and C. Strickland (1914) has described others. In the present paper it is proposed to describe and illustrate the salient features of the mature forms of known larvae and to indicate by means of a synoptic table a method of identification of species. As all the larval structures here referred to are paired, description of them is made easier by reference to those of one side only.

Larvae may conveniently be examined in a drop of water on a glass slide, the larva having been immobilised by exposing it to chloroform vapour or killed by adding a drop of weak formalin solution. They may be mounted as permanent specimens in weak formalin solution (5 per cent.) in a cell formed of a ring of paraffin.

Key to the known mature larvae of Malayan Anophelines.

1.	Shaft of antenna with a branched hair..	2
	Shaft of antenna without a branched hair	5
2.	Outer anterior clypeal hair thickly branched; abdominal segments with large stellate tufts	3
	Outer anterior clypeal hair with few branches; abdominal segments without stellate tufts	13. *umbrosus.*
	Outer anterior clypeal hair simple or bifid terminally	4
3.	Innermost sub-median anterior thoracic hair (fig. 3) branched from base	4. *barbirostris.*
	Innermost sub-median anterior thoracic hair with simple stem and four or five short branches terminally	11. *sinensis.*
4.	Posterior clypeal hair short, branched	2. *aitkeni.*
	Posterior clypeal hair long, simple (C. Strickland)	3. *asiaticus.*
5.	Inner and outer anterior clypeal hairs branched	6
	Inner and outer anterior clypeal hairs simple, or inner only with minute lateral branches	9
6.	Posterior clypeal hairs long, simple; no stellate tufts on thorax or abdominal segment i	7
	Posterior clypeal hairs short, branched; stellate tufts on thorax and abdominal segment i	8
7.	Filaments of leaflets of stellate tufts on mid-abdominal segments sharply pointed	9. *maculatus.*
	Filaments of leaflets of stellate tufts on mid-abdominal segments truncated	6. *karwari.*
8.	Outer anterior clypeal hair with short lateral branches ..	1. *aconitus.*
	Outer anterior clypeal hair thickly branched	5. *fuliginosus.*
9.	Stellate tufts on abdominal segments i–vii	10
	Stellate tufts on abdominal segments ii–vii	11
	Stellate tufts on abdominal segments iii–vii	12
10.	Posterior clypeal hairs closer together between inner anterior clypeal hairs	10. *rossi* var. *indefinitus.*
11.	Stellate tuft on thorax fully developed..	7. *kochi.*
	No stellate tuft on thorax	8. *leucosphyrus.*
12.	Outer anterior clypeal and posterior clypeal hairs very short	12. *tessellatus.*

1. **Anopheles aconitus,** Dönitz, (=albirostris, Theo.), (fig. 4).

Average length at maturity 3·5 m.m.

HEAD: *Anterior clypeal hairs.* Inner hair long and stout with numerous short lateral branches. Outer hair about half the length of the inner and similarly branched. *Posterior clypeal hairs* short, branched from the base into four or five divisions. *Occipital hairs* short, branched from the base into four or five divisions.

THORAX: On the posterior quadrant a fully developed stellate tuft composed of twelve to fourteen long narrow leaflets without terminal filaments.

ABDOMEN : On segment i. a fully developed stellate tuft composed of ten to twelve short narrow leaflets with ill-defined terminal filaments. On segments ii.-vii. large stellate tufts composed of fifteen to eighteen leaflets with well defined terminal

Fig. 4. *Anopheles aconitus*, Dön.

filaments. The average total length of the leaflets on the mid-abdominal segments is 0·08 mm. ; the average relation of length of filament to total length of leaflet is as 1·5 to 4. The filament is deeply indented at its base and is sharply pointed.

2. **Anopheles aitkeni,** James, (figs. 5, 6).

Average length at maturity 3·5 mm.

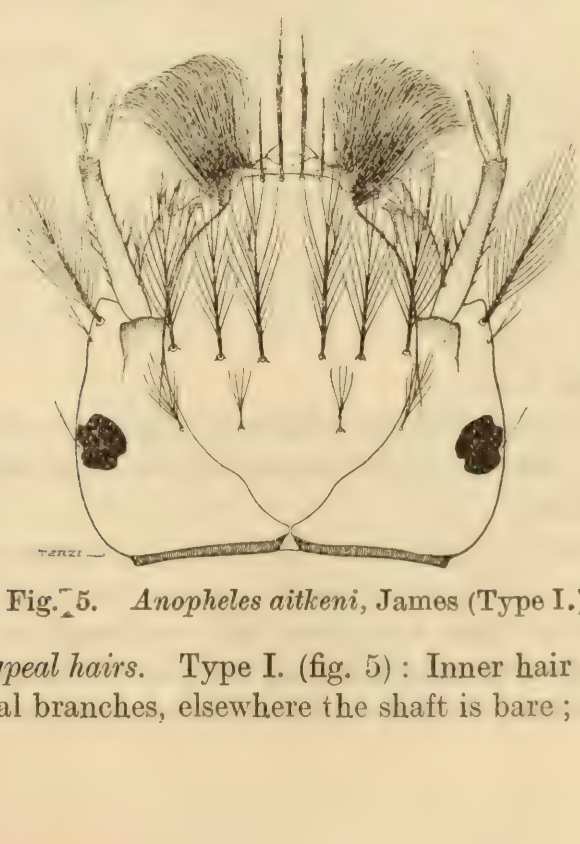

Fig. 5. *Anopheles aitkeni*, James (Type I.).

HEAD : *Anterior clypeal hairs.* Type I. (fig. 5) : Inner hair long and stout, middle third with short lateral branches, elsewhere the shaft is bare ; outer hair short, one-

third the length of the inner, simple. Type II. (fig. 6): Inner hair long, basal third or stem stout and bare; at the end of the stem the hair branches into three to six divisions, each equal to twice the length of the stem; outer hair short, usually simple, but may be bifid at its extremity. *Posterior clypeal hairs* short, branched from the base into three or four divisions. *Occipital hairs* short, branched, the inner with three divisions, the outer with five or six divisions. *Antenna* carrying a stout branched hair placed dorsally on the shaft near the base.

Thorax: On the posterior quadrant a fully developed stellate tuft composed of long narrow leaflets without filaments.

Abdomen: Segment i. carries a stellate tuft composed of five to seven short narrow leaflets without filaments. Segments ii.–vii. carry fully developed stellate tufts composed of fifteen to twenty broad leaflets with well defined filaments. The average length of the leaflet on the mid-abdominal segments is 0·075 mm. The average relation of length of filament to total length of leaflet is as 1 to 4. The filament is deeply indented at its base and sharply pointed.

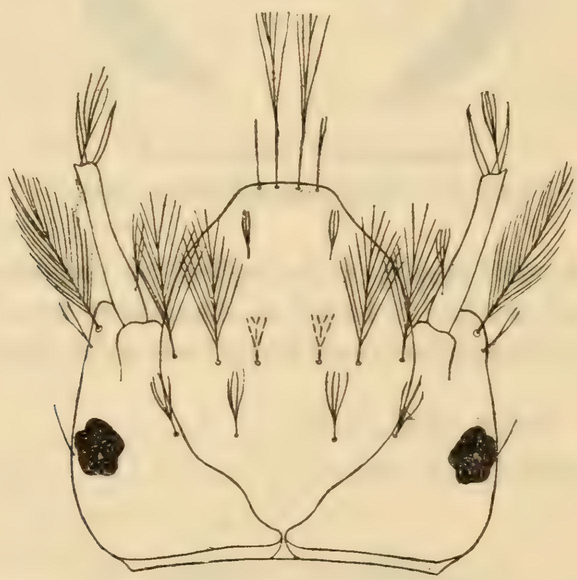

Fig. 6. *Anopheles aitkeni*, James (Type II.).

Alone among the larvae of Malayan Anophelines that of *aitkeni* exhibits variation in the form of the anterior clypeal hairs. Two principal types are here described, but it has been observed that combinations of these occur, even on different sides of the same larva.

3. **Anopheles asiaticus,** Leic.

The mature larva of this rare species was first described by C. Strickland (Parasitology, vii, p. 12, 1914), who has kindly permitted me to examine his specimens and to reproduce his description.

Head: Clypeal hairs. (i) Anterior: The internal hairs are long, stout, and close together, as in members of the *Myzorhynchus* group, and are bifurcate about their middle. (ii) The *external* hairs are about half the length of the internal, stout, projecting forwards and outwards, and simple. (iii) *Posterior*: These hairs are a little longer than the external ones and are simple and delicate.

The *frontal hairs* are six in number as usual, but only the two external ones are branched. The four internal hairs are very delicate. The *antennae* each possess a branched hair, as in *barbirostris* and *sinensis*, and the Indian species *lindesayi*, but it is situated on the *external* side of the antenna.

THORAX: There are no palmate hairs on the thorax. There is a deposit of black pigment in the form of a Maltese Cross, the posterior limb of which is bilobed.

ABDOMEN: In this region of the body the palmate hairs are slightly developed on the 2nd segment, well developed from the 3rd to 7th segment; they are large and pigmented. Each leaflet is long and rather slender, terminating in a long filament without any very jagged shoulder. There is a dense black spot on the dorsum of the 4th segment."

A hair situated on the dorsum of the head near the base of the antenna ("basal hair" of James and Liston) is of unusual form in this species. In most Anophelines this hair is stout and feathered—in *asiaticus* it is long, slender and bifurcate terminally. The occipital hairs are short, slender and simple. The average length of the leaflet in the stellate tufts of the mid-abdominal segments is 0·08 mm. The average relation of length of filament to total length of leaflet is as 1 to 2·5.

I have found in the water of cut bamboos an immature Anopheline larva which is perhaps one of the early stages of *asiaticus*. It differs from the mature form described by Strickland in the form of certain of the head hairs. In my specimen the inner anterior clypeal hair has four to five lateral branches, the "basal hair" consists of a simple stem with a swollen extremity carrying a tuft of hairs (as in the larva of the Indian species *culiciformis*). The posterior clypeal hairs are minute, only about half the length of the outer anterior clypeal hairs. The outer pair of frontal hairs are branched as in *asiaticus*, the median pair short and simple, the inner pair long and bifurcate. A branched hair is borne on the antenna and stellate tufts are present on abdominal segments iii. to vii. only. There is a deposit of pigment of irregular form in the cuticle of the dorsum of the thorax.

4. **Anopheles barbirostris,** Van der Wulp, (fig. 7).

Average length at maturity 5·5 mm. The larva of this species is usually dark-coloured, with light bands across the front of the thorax and abdominal segments iii., v. and viii.

HEAD: *Anterior clypeal hairs.* Inner hairs close together, long and simple; outer hairs shorter, thickly branched. *Posterior clypeal hairs* short, branched, with three or four divisions. *Occipital hairs* short, both branched, with seven or eight divisions. *Antenna.* On the inner surface about the middle the shaft carries a long branched hair.

THORAX: Sub-median anterior thoracic hairs (fig. 3) as follows, from the mid line:—(1) a short hair branched near the base, with six divisions; (2) a long stout plumose hair; and (3) a long simple hair externally. On the posterior quadrant a fully developed stellate tuft composed of twelve to fifteen long narrow leaflets without filaments (fig. 3, *b*, B).

ABDOMEN: Segment i. carries a fully developed stellate tuft composed of eight to ten long narrow leaflets without filaments. Segments ii.–vii. carry fully developed stellate tufts composed of about twenty long broad leaflets. The average length

of the leaflets on the mid-abdominal segments is 0·11 mm. The average relation of length of filament to total length of leaflet is as 1 to 2·2. The filament is marked off from the remainder of the leaflet only by minute indentations along its edges.

Fig. 7. *Anopheles barbirostris,* Wulp.

5. **Anopheles fuliginosus,** Giles, (figs. 8, 9).

Average length at maturity 4·0 mm.

HEAD: *Anterior clypeal hairs.* Inner hair long and stout, with short lateral branches; outer hair about half the length of the inner, thickly branched. *Posterior*

Fig. 8. *Anopheles fuliginosus,* Giles

clypeal hairs short, branched from the base, with five or six divisions. *Occipital* hairs, both short, branched, with five to seven divisions.

THORAX: On the posterior quadrant a fully developed stellate tuft, composed of twelve to fifteen long narrow leaflets without filaments.

ABDOMEN: Segment i. carries a fully developed stellate tuft composed of eight to ten long narrow leaflets with ill-defined filaments. Segments ii.–vii. carry large stellate tufts composed of fifteen to twenty broad leaflets with well defined filaments (fig. 9). The average length of the leaflets on the mid-abdominal segments is 0·085 mm. The average relation of length of filament to total length of leaflet is as 1 to 2·5. The filament is deeply indented at its base and is sharply pointed.

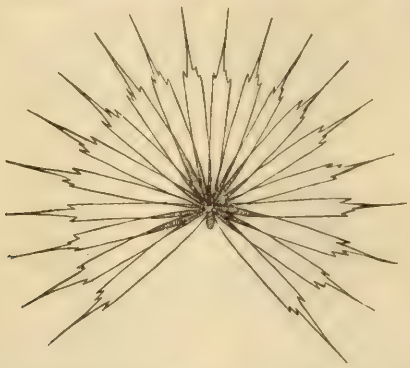

Fig. 9. *Anopheles fuliginosus*, Giles; stellate tuft.

6. **Anopheles karwari,** James, (fig. 10).

Average length at maturity 4·5 mm.

HEAD: *Anterior clypeal hairs.* Inner hair long and stout, with fine lateral branches; outer hair shorter and similarly branched. *Posterior clypeal hairs* long, slender, sometimes with lateral branches. *Occipital hairs.* Inner long, simple; outer long, branched, with four or five divisions.

Fig. 10. *Anopheles karwari*, James.

THORAX without a stellate tuft.

ABDOMEN: Segment ii. carries a stellate tuft composed of eight to ten narrow leaflets without filaments. Segments iii.–vii. carry stellate tufts composed of fifteen

to eighteen short, broad leaflets with filaments. The average length of the leaflets on the mid-abdominal segments is 0·06 mm. The average relation of length of filament to total length of leaflet is as 1 to 6. The short filament is indented at its base and truncate.

7. **Anopheles kochi,** Dönitz,* (fig. 11).

Average length at maturity 4·0 mm.

HEAD: *Anterior clypeal hairs.* Inner hair long and slender, generally with few lateral branches; outer hair very short, about one-fourth the length of the inner, simple. *Posterior clypeal hairs,* short, simple. *Occipital hairs,* both long, inner simple, outer branched.

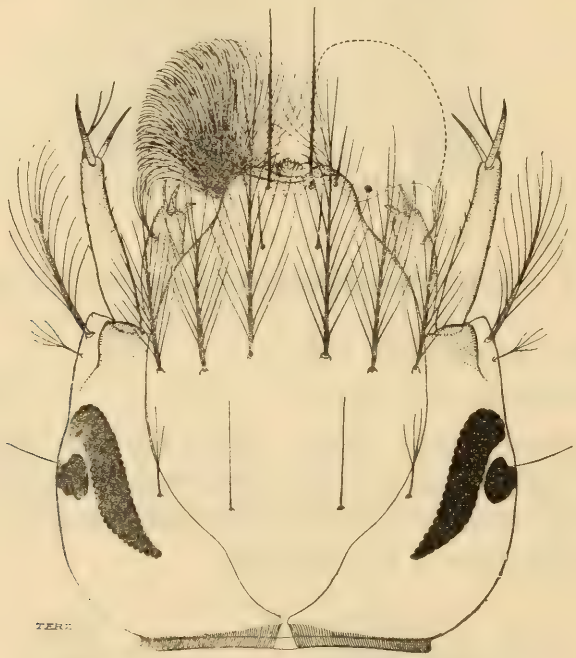

Fig. 11. *Anopheles kochi*, Dön.

THORAX: On posterior quadrant a fully developed stellate tuft composed of ten to twelve long narrow leaflets without filaments.

ABDOMEN: Segment ii. carries a stellate tuft composed of five to seven short narrow leaflets without filaments. Segments iii.–vii. carry stellate tufts of fifteen to eighteen short narrow leaflets with filaments. The average length of the leaflets on the mid-abdominal segments is 0·60 mm. The average relation of filament to total length of leaflet is as 1 to 3·5. The filament is slightly indented at its base and tapers gradually to a point.

8. **Anopheles leucosphyrus,** Dönitz, (fig. 12).

Average length at maturity 5·0 mm.

HEAD: *Anterior clypeal hairs.* Inner hair very long and slender, simple; outer hair about one-half the length of the inner, simple. *Posterior clypeal hairs,* long, simple. *Occipital hairs,* both long, inner simple, outer branched.

THORAX without a stellate tuft.

* See also Bull. Ent. Res., v., p. 129 (1914).

ABDOMEN: Segments ii. and vii. carry fully developed stellate tufts composed of eight to twelve long narrow leaflets without filaments. On segments iii. to vi. the leaflets number fifteen to eighteen and have well defined filaments. The average

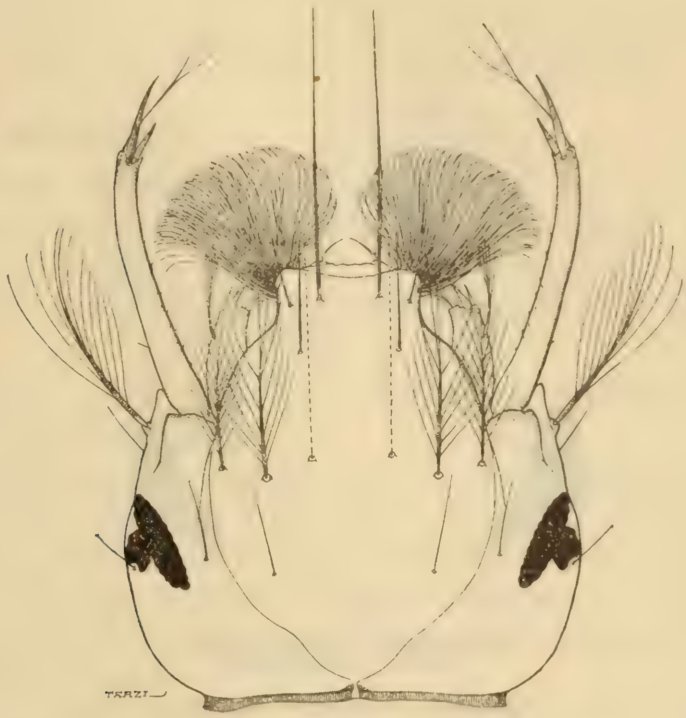

Fig. 12. *Anopheles leucosphyrus*, Dön.

length of the leaflets on the mid-abdominal segments is 0·10 mm. The average relation of length of filament to total length of leaflet is as 1 to 2·5. There are several indentations at the base of the filament, which is sharply pointed.

9. **Anopheles maculatus,** Theo. (*cf.* fig. 10).

Average length at maturity 4·5 mm.

The larva of this species differs from that of *karwari* only in the form of the leaflets of the stellate tufts of the mid-abdominal segments. In *maculatus* the average length of these leaflets is 0·06 mm. The average relation of the length of the filament to the total length of the leaflet is as 1 to 4. The filament is deeply indented at the base and is sharply pointed.

10. **Anopheles rossi,** var. **indefinitus,** Ludl. (figs. 13, 14).

Average length at maturity 5·0 mm.

HEAD: *Anterior clypeal hairs.* Inner hair long, slender, simple; outer hair, short, simple. *Posterior clypeal hairs* short, simple, being placed unusually far forwards on the clypeus and between the inner pair of anterior clypeal hairs. This arrangement of clypeal hairs is characteristic for this variety. *Occipital hairs.* Inner hair long, simple; outer hair branched.

THORAX without a stellate tuft.

ABDOMEN : Segment i. carries a stellate tuft composed of five to seven long narrow leaflets without filaments. Segments ii.-vii. carry stellate tufts composed of fifteen to eighteen long narrow leaflets with well defined filaments (fig. 14). The average

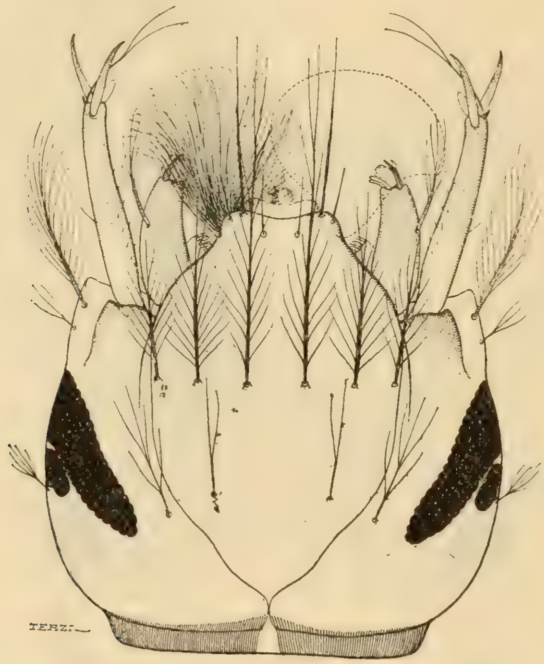

Fig. 13. *Anopheles rossi* var. *indefinitus*, Ludl.

length of the leaflets on the mid-abdominal segments is 0·08 mm. The average relation of length of filament to total length of leaflet is as 1 to 2. The filament is deeply indented at its base and is unusually long and slender.

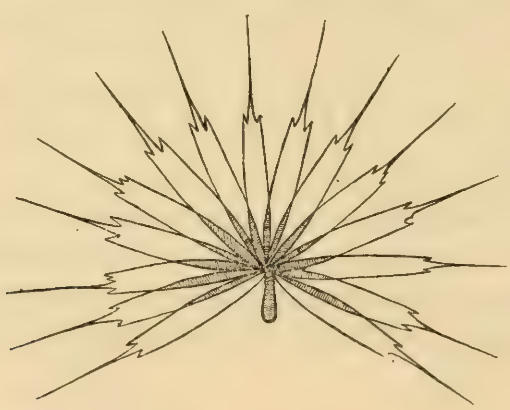

Fig. 14. Stellate tuft of *A. rossi* var. *indefinitus*, Ludl.

11. **Anopheles sinensis,** Wied. (*cf.* fig. 7).

Average length at maturity 5·5 mm.

The larva of this species can usually be differentiated by the naked eye appearances from that of *barbirostris*. The larva of *sinensis* is coloured greenish or yellowish brown, instead of black, as is *barbirostris* ; also *sinensis* lacks the whitish bands which are so characteristic of *barbirostris*.

The only microscopic character by which these larvae may be differentiated is the form of the innermost of the submedian anterior thoracic hairs (fig. 3). In *sinensis* this hair has a long simple stem, which is seen when highly magnified to be branched near the end. This minute difference has proved to be constant in a large number of specimens of cast larval skins which have been examined. Other larval characters in which it has been alleged that differences exist between *sinensis* and *barbirostris* have been found to be identical in the two species.

12. **Anopheles tessellatus,** Theo.*

Average length at maturity 4·0 mm.

HEAD: *Anterior clypeal hair.* Inner hair stout, of medium length, with minute lateral branches; outer hair short, only about one-fifth the length of the inner, simple. *Posterior clypeal hairs* short, slender and simple. *Occipital hairs* short, both branched.

THORAX: On the posterior quadrant a rudimentary stellate tuft composed of five to seven narrow lanceolate leaflets.

ABDOMEN: Segments iii.–vi. carry fully developed stellate tufts composed of leaflets with ill-defined filaments. On segment vii. the leaflets are narrowly lanceolate, without filaments. The average length of the leaflets on the mid-abdominal segments is 0·06 mm. The average relation of length of filament to total length of leaflet is as 1 to 3. The indentations at the base of the filament are minute and the filament tapers gradually to a point.

13. **Anopheles umbrosus,** Theo. (fig. 15).

Fig. 15. *Anopheles umbrosus,* Theo.

Average length at maturity 5·0 mm.

HEAD: *Anterior clypeal hairs.* Inner hair long, simple; outer hair with few branches as compared with the allied species *sinensis* and *barbirostris*; the usual

* See also Bull. Ent. Res., iv., p. 129 (1913).

arrangement is division of the stem near the base into two, each of which bears two or three branches. *Posterior clypeal hairs* short, branched, with three or four divisions. *Occipital hairs* stout, branched. *Antenna* carrying on its inner side a long stout branched hair.

Thorax: Sub-median anterior thoracic hairs as in *sinensis*. No stellate tuft.

Abdomen: There is no stellate tuft on any segment of the abdomen. This is a unique character; all other Anopheline larvae so far described bear stellate tufts on several segments of the abdomen. In this species the corresponding structure is a much-branched plumose hair.

OBSERVATIONS ON INSECT PESTS IN GRENADA.*

By H. A. Ballou,

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The Cacao Thrips (*Heliothrips rubrocinctus*, **Giard**).

This insect has been known in Grenada since 1898, and has been considered a pest of cacao by planters and others. At the present time thrips probably occurs in all parts of Grenada ; at least, I found it or saw the results of its presence in all parts of the island which I visited, and I think I might say in every field. It was, however, only in certain fields, and often in small areas in those fields, that planters considered that damage had resulted. The remarkable thing about the occurrence of thrips is that it appears year after year on the same areas, even on the same trees, though sometimes spreading a little; but a thrips area one year is liable, or certain, to be a thrips area every year.

It appears that a sufficient amount of information is now available to enable a general statement to be made as to the economic status of the cacao thrips.

Mr. Lefroy stated in the report on his visit to Grenada, dated 3rd October 1900, that the discoloration of the pods which results from thrips attacks makes it difficult to tell when they are ripe and that this increases the cost of gathering, since the pods have to be tapped or scratched in order that the pickers may be able to see their real colour. Otherwise this insect does not appear in any way very injurious or troublesome, and none but a very simple remedy would be worth adopting. After he had made two visits to Grenada with special reference to this insect, Mr. Lefroy summarised the situation in the following words :—" Thrips may be regarded as a possible enemy to cacao rather than as an actual pest. There does not appear to be any serious cause for alarm at the present time and the chance of the cacao suffering materially from the attacks of this insect is, in my opinion, remote " (" West Indian Bulletin," ii, 1901, p. 185).

This opinion appears to me to be applicable at the present time, the experience of cacao-planters during the past fourteen years having served to confirm the early belief as to the nature of the attacks. At the same time, it must be stated that the cacao-growers still refer to the injury done by thrips and they recognise on their estates certain fields, or patches in fields, where thrips attacks occur year after year, and they also want to know what remedies to employ to check them.

Formerly I was under the impression that the cacao thrips was always most abundant during dry weather and that wet weather was favourable to the plants and unfavourable to the insect. This idea is based on observations, correspondence and interviews with planters and others, and has been put forward in Departmental publications and Agricultural Conferences from time to time during the past few years and no exception to the general idea has ever been taken. In the *Circular* on Cacao

*Extracted from a report sent by the Imperial Commissioner of Agriculture, B.W.I., to the Colonial Office.—Ed.

Thrips by F. W. Urich, published by the Trinidad Board of Agriculture, the same belief is expressed. On referring to my report on my visit to Grenada in 1904, I find that it is recorded there that in the case of an estate where a severe attack of thrips had taken place and where these insects were said to have caused the death of the cacao trees, the thrips had occurred in November and December. During this last visit to Grenada, I took every opportunity to obtain from planters information with regard to the times of occurrence of thrips and the kind and amount of injury to the trees. As a result, I formed the opinion that in Grenada, especially on those estates which lie on the lower lands around the periphery of the island, the cacao thrips is most abundant during the last three months of the year, October, November and December, and that in the dry months a considerable improvement in the condition of the trees takes place.

With regard to the nature and amount of injury caused by thrips, I found that, generally speaking, planters notice only the injury in terms of pods picked too green and of labour and time lost in scratching the pod to see if it is ripe enough to be picked. It is true that in some instances thrips are credited with causing the leaves to fall and with preventing the development of pods when these are attacked while very young, and it appears that in a few instances they are believed to have killed trees out-right.

Thrips live and feed on the leaves and pods of the cacao. When leaves are attacked they may be so seriously injured as to cause them to drop, but unless the entire crop of leaves were destroyed and the destruction repeated in a short time, it does not seem to me as if the tree would be seriously injured and it certainly would not be killed from that cause alone. The attack on growing pods would not have any effect on the health and vigour of the tree, even if all the pods were killed. In most instances, planters have spoken of a severe thrips attack as being a time when thrips were abundant on the pods, as a result of which the latter would be badly discoloured. I have specially asked them to state how much damage has been caused to the crop and how much permanent damage has been done to the trees. In nearly every case the answer has been that very little shortage of the crop is traceable to thrips attack and that the few leaves which fall are quickly replaced by new growth, but the loss occurs in the pods picked before they are ripe and in the loss of time by the pickers, who often have to examine nearly all the large pods on the tree in order to know which are ready for picking.

I discovered a remarkable unanimity of opinion among Grenada cacao-planters in regard to the occurrence of thrips during this last visit. In every instance where I was shown thrips attacks or the effects of thrips I was told that "this piece gets it every year," but in every instance something besides thrips could be shown to be wrong with the trees. Before considering what these other factors are, I would draw attention to four points with regard to the cacao thrips in Grenada :—(*a*) Thrips are present throughout the island, and at certain times it is doubtful if on those estates where outbreaks of thrips occur there are any trees which are entirely free from this insect ; (*b*) thrips in the adult stage are capable of flight and the active young might readily be carried from tree to tree by birds and large insects ; (*c*) thrips attacks occur on the same limited areas year after year ; (*d*) thrips is a dry weather and a dry locality insect as a general thing, and yet in Grenada it generally becomes most troublesome towards the end of the wet season.

In the case of an insect which is at all times well distributed throughout the island, and which can migrate and can easily be transported, it is remarkable that their attacks should always occur on limited areas and on the same areas year after year, and that these attacks should occur in the wet season, which would be expected to be the time when the plants would do their best and the thrips would be reduced in numbers. It seems to be generally accepted that this species may be present year after year in cacao and never increase in numbers sufficiently to attract attention or to cause any injury.

For several years I have been convinced that the so-called attacks of thrips indicate that something is wrong with the plant, or with the conditions under which it is growing. I now suggest that thrips, in Grenada at least, ought to be considered a useful insect, because it is a certain indicator that the trees are suffering from some untoward condition. It might well be called a danger signal, but should not be called a pest. To explain this statement, I may say that whenever I was shown thrips attacks, I found root disease, or insufficient drainage, or very shallow soil with terrace or heavy clay beneath, or a lack of humus.

Root disease is the result of the action of a specific organism which produces a well known and recognisable effect on cacao. Its attacks seem always to be accompanied by thrips, which probably indicate the area of infection by root disease better than it can be determined in any other way. The worst affected trees, probably in the centre of the infected patch, will be dying wholly or in part, and of course the effect of root disease is easily to be seen in such cases, but on the edge of the patch where its effects might not be readily detected the thrips will almost certainly be found to decrease in numbers. Root disease probably produces a physiological disturbance in the cacao tree long before it causes the death of the tree or even of many of the roots. This condition is favourable to thrips and results in their increase in numbers. Cacao trees growing in soils not properly drained are also subject to physiological derangement and consequently to thrips attacks. I was shown several instances where trees had been freed from the insects by drainage.

In this connexion, I wish to record my impression that in Grenada there are many instances of insufficient drainage due to the wrong construction of the drains. Too many drains run nearly straight down the slope of the gradient instead of across it. In other words, there are too many direct run-off drains, and not enough contour drains. The proper arrangement and construction of drains in cacao is one that allows rain and other water thoroughly to saturate the soil, and at the same time provides for a rapid removal of all surplus water. Proper drainage also reduces surface wash in times of heavy rainfall and rapid run-off, and prevents or reduces land-slipping. Direct down-hill water-courses increase wash and land-slipping. In the matter of depth also many drains are deficient, and this is somewhat due perhaps to a wrong method of calculating depth. I have heard a planter give the depth of his drains as to the top of the bank, not to the original level of the surface soil. Another weak point in drainage in Grenada is that in some instances the soil thrown out of the drains is allowed to lie in ridges in such a manner that pockets or depressions are formed in which there is little or no chance for the surface water to get directly into the drains; it must stand on the surface until it percolates. In such instances, the tree stands in the lowest part of such a place and the water settles round it. These

remarks on drainage have been made at some length because I believe that of all the causes of the attacks of cacao thrips in Grenada, insufficient or bad drainage is perhaps the most common, whilst the attacks of root diseases are nearly as often a cause.

The other inducing causes of thrips, mentioned above, shallow soil with a hard or heavy subsoil and a lack of organic matter in the soil, may be dealt with together. These conditions should be apparent to any careful observer, more especially if it can be impressed on all who have to do with cacao-growing that in the event of a severe attack of thrips the first thing to do is to consider carefully the soil conditions. To improve such soils, the subsoil should be opened up by deep forking or trenching, followed by an application of lime and subsequent heavy and frequent applications of organic matter in every available form. If the cacao-planter believes that the attack of thrips is so severe as to interfere with the development of the pods already formed, or if he is convinced that the trees are actually suffering, he may resort to spraying as an emergency measure, but he should remember that spraying is only a temporary expedient of no permanent value in itself. The effective control of thrips will only be secured by the eradication of root disease, better drainage and better soil conditions generally.

The Cacao Beetle (*Stirastoma depressum*, **L.**).

The cacao beetle has been known in Grenada for 25 years or more ; it is generally distributed over the island and is probably well known to planters and small proprietors. In abundance, it varies from being very plentiful in some districts to very scarce in others. It is said to be most troublesome on the leeward side of the island where it is to be found both on estates where great care is exercised and considerable amounts of money are expended in efforts to control it, and on cacao which receives little or no care. On the other hand, in certain districts this insect is not a pest and does not occur in sufficient numbers to necessitate the adoption of remedial measures, and this condition exists both where cacao is well cared for and where it is neglected.

There can be no doubt that the cacao beetle is a serious pest in places, and is capable of becoming so in most other localities. In the Circular No. 1 of the Board of Agriculture, Trinidad, entitled " The Life-History and Control of the Cacao Beetle," Guppy states that this beetle is the worst pest that the cacao-planter has to deal with. I did not see any very bad cases of beetle attack in Grenada during this visit, but I saw both the beetle and larvae and evidences of their work. On each estate the thrips places were seen, because the planter generally regarded the thrips as more serious than the beetle ; another reason for this is that thrips areas are definite and constant, while, so far as I gathered, the beetle is not confined to any restricted area. It occurs as a pest in several districts of the island, and often on certain portions of the estate, but not as a pronounced feature on well defined areas.

Good accounts of the cacao beetle, its method of attack, and measures to be adopted for its control have been published by this Department. Pamphlet No. 58 entitled " Insect Pests of Cacao, 1909," contains such an account, and more recently (1911) the Trinidad Board of Agriculture has issued Circular No. 1, mentioned above, from which it is learned that the cacao beetle may develop from egg to adult in about 80 days, as follows :—Egg 5 days, larva 63 days, pupa 12 days. The adult beetle may

live for about two months more, making a total of some 140 days. It contains also an account of the use of the Chataigne Maron or Bread Nut (*Pachira aquatica*) for trapping the beetle. This tree is a natural food-plant of the cacao beetle and is probably preferred by it to the cacao. The chataigne wood is cut into lengths suitable for use in any of the several kinds of trap recommended. These are four in number :— (1) the heap trap consists of a heap of small branches two to four feet in length laid on the ground ; the beetles are attracted to these heaps and lay their eggs there ; the heaps should be burned or deeply buried at the end of six weeks ; (2) the suspended trap consists of a bit of chataigne wood suspended by a wire among the branches of the cacao tree ; (3) the leading trap consists of longer pieces of chataigne resting with one end on the ground and the other between the branches at the fork ; (4) fork traps consist in the use of small pieces of the chataigne placed between the branches at the fork. All these traps have the same object, that is to provide an acceptable place for the beetles to lay their eggs, and to be effective they must be renewed as soon as they become dry. These bits of trap wood must be burned or deeply buried in order to kill the grubs which hatch from the eggs.

Spraying with arsenate of lead is also recommended in Trinidad, especially in connexion with the use of the traps. The arsenate for this purpose is used at the rate of 1 pound to 10 gallons of water. The poison should be well mixed to form a smooth paste in a small quantity of water and then added to the full amount. It should be applied with a powerful pump and fine nozzle, and the mixture in the spray tank must be kept agitated all the time ; 50 gallons should spray 100 trees. In spraying for beetle it is essential to cover the bark thoroughly from the collar (ground level) up into the small branches.

The Acrobat ant (*Cremastogaster* **sp.**).

The only new insect which seems at present to threaten to become important as a pest of cacao in Grenada is the acrobat ant. This insect, or perhaps a closely related species of the same genus, was described in the *Agricultural News*, Vol. xiii ,p. 298, 12th September 1914. It is a small, black or very dark brown ant, which lives on trees and is characterised by its habit of turning up its abdomen over its back, as it were.

I noticed that it often occurs in great abundance on a small, well defined area, and that at a distance of a few yards there are none to be found. I did not see many spots in Grenada where the acrobat ant was actually doing much harm, but from what I did see and from what I know of the Barbados acrobat, I regard this insect as possessing great possibilities of becoming a cacao pest in the future. I might venture so far as to say that it seems to me possible that the acrobat ant may become the most serious cacao pest in Grenada. Some of the features in the economy of this insect which make this outcome seem possible are the following :—

(1) The location of the nests. The nests of this species are formed in crevices of the bark or wood of living trees, or in or upon dead trees, in fences, and out-buildings. Broken or splintered wood resulting from bad pruning, loose bark from the same cause, a leaf which adheres to the surface of the bark, all these give nesting opportunities to the acrobat ant, while the central pith in a cut branch, or the tunnels of boring insects, are specially attractive to them for the purpose.

(2) The size of the nest or colony. The ant lives in very small colonies; often the nest is no more than the collection of a few workers, eggs, larvae, pupae, and one or more egg-laying females, located under a leaf or bit of bark. The destruction of nests or colonies, when they are so small, so numerous and so well protected, would present enormous difficulty as a control measure.

(3) Their method of feeding. This species of ant damages trees directly. The ants get into cuts made by pruning and into wounds made by boring insects, especially when the bast and cambium are exposed, and they seem to feed there in such a manner as to prevent these cuts and wounds from healing over.

(4) Their association with other insects. In nearly every instance where the acrobat ant was noticed in cacao in Grenada it was associated with the mealy bug (*Pseudococcus citri*), and in most cases where the mealy bug was seen the ant was also present. I did not realise the possibility that these two insects were closely associated until my visit was nearly over, so that I am not certain that this conclusion will be borne out by more extended observation.

The only remedial measures which seem practical at present have to do with better pruning and care of the cacao trees, with a view to eliminating breeding places of the ant as far as possible and to preventing the damage resulting from the feeding of the ants on exposed cambium and bast tissues. The cacao tree would seem to be protected from this ant by nature, since its hard, smooth bark offers very little opportunity for its nests. Trees with a rough scaly bark, like mahogany for instance, are very suitable for this purpose. In this connexion, I may say that while I saw on certain estates evidences of excellent pruning methods and good care of trees, I also saw some cacao trees where these matters were much neglected; dead stubs, cavities of all sizes resulting from borer attacks which had been neglected or badly treated, and from the rotting out of cut stubs or broken branches, being much in evidence. Such conditions are favourable to the ant, and all well directed effort toward better care of the trees will have an effect in reducing the numbers of this insect.

I should judge from what I saw that the cacao-planters want some dressing for wounds made in pruning more efficient than anything they have at present. The effects of good pruning are lost to some extent because the dressing used does not protect the wood until it heals over, and the wood rots out; cavities are thus produced which tend to shorten the life of the tree. At the present time, lead paint, coal tar, and resin oil to which tar is added to give colour, are the wound dressings used on cacao trees. I am not able to recommend anything better, but experiments ought to be undertaken with a view to finding some material which would give a greater protection to exposed surfaces of wood. In this connexion, trials might be made of solignum, carbolineum, and similar wood preservatives.

Black Blight.

Black Blight is a fungus which does not attack the plant on which it grows. It obtains its nutriment from the secretions of insects. Speaking generally it may be stated that the only injury it causes to plants is that it cuts off a certain amount of light from the leaves on which it occurs and thus interferes with their physiological activities.

The insects which are most generally associated with black blight are the COCCIDAE, although it accompanies other insects. The presence of black blight may nearly always be taken as an indication of the presence of scale-insects or mealy bugs, or both, on the trees or other plants where it is seen or on adjoining and overhanging trees. That is to say, it often happens that when tall trees are infested with scale-insects, other trees of lower growth, shrubs, and even the rocks and soil below may be covered by black blight, which is the result of the fungus growing on the nutritive substances which have dripped down from above.

It should be stated that it is possible for black blight to occur without the aid of insects of any sort, as in the case of plants which produce a profusion of flowers secreting an abundance of nectar. If this nectar drops on the leaves, black blight may develop on it. The black blight fungus also develops on extra-floral nectaries, such as those formed on the principal veins at the back of a cotton leaf.

It seems to me that it is especially unfortunate that in Grenada reference is so constantly made to black blight as a pest. If planters and others would learn to refer to the insects which induce the growth of black blight and not to the comparatively harmless, though conspicuous, fungus, it would be much easier to discuss the problem with them. In general, it may be said that to attempt to deal with the black blight question under the comprehensive term " black blight " will in the future yield no better results than in the past. It might be compared to the efforts of medical men attempting to treat all the different fevers under the one head " fever." It is possible to render some relief, but cures are next to impossible.

In considering the amount of damage done by scale-insects, and generally spoken of as black blight, it must be remembered that the amount of black fungus visible upon a tree or landscape is no indication of the damage done. Any estimate of this must be based on the yield of fruit or other product, and on the growth and health of the tree. Scale-insects, for instance, may so seriously interfere with the natural functions of the tree as to cause a falling off of the amount of fruit produced and to injure it to such an extent as to cause twigs and branches to die and sometimes to bring about the death of the whole tree. In considering any remedial measures for the control of those insects which are accompanied by black blight, the amount of the damage done must be estimated in order that calculations may be made as to the expense that should be incurred for the purpose.

One of the reasons for embarking on a campaign against black blight in Grenada arises from the idea that the fungus and the scale-insects are likely later to attack cacao, when other food-plants are killed off. This supposition is not well founded. In the first place the blight-infested trees are not often killed out either by the scale-insects or the fungus. In the case of mangoes, which are perhaps the most universally and most thoroughly scale-infested and blighted of all the Grenada trees, it would be difficult, I believe, to find any trees killed out-right by this cause. I have asked several people to show me such a dead or dying tree, but I have not been shown one yet. Moreover, not all mangoes are scale-attacked and blighted, and those that are affected put out a full covering of new leaves each succeeding year.

In the second place, cacao is not very susceptible to the attacks of scale-insects, or any insects which induce the growth of black blight. At the present time, so far

as I am aware, cacao in Grenada is known to be attacked by only two scale-insects. These are the common mealy bug (*Pseudococcus citri*) and the akee fringed scale (*Asterolecanium pustulans*). I have seen the common mealy bug present in some numbers on the leaves and pods of cacao, but they do not seem to do any appreciable harm, and the cacao-planter does not consider that it would be worth while to spray his trees for the control of this insect. As for the other scale mentioned, it was reported a few years ago as seriously attacking one tree in a peasant's cacao plot and it was recommended that the tree should be destroyed. On this recent visit, I found a few specimens of this insect on a cacao tree, but so few that they could not be said to be doing any appreciable harm. Any planter can control these insects if they tend to become seriously abundant.

Cacao has been grown in Grenada for many years, and for the last twenty-five years, perhaps, it has been the principal crop. Most, if not all, the scale-insects which occur as pests in Grenada either are indigenous to that island or have been established there for a long time. No new scale-insect pests seem to have made their appearance in Grenada during the sixteen years that this Department has been working, and it may be stated with certainty that if any of the known insects in Grenada were likely ever to become pests of cacao they would have manifested that tendency before this. It is known also that scale-insects do not often change their food-plant, or at least, they usually have a narrow range of food-plants. There are not apparently many species of trees in Grenada closely related to the cacao, from which scale-insects might spread to that tree.

In the matter of fruit trees, the situation is somewhat different. The scale-insects which attack the orange, lime and other citrus trees are serious pests. In Grenada, the mango trees are often thoroughly infested with black blight, and it is in connexion with these trees perhaps that it is most commonly noticed. Whatever injury the mangoes suffer is not, however, the result of the black covering so much as of the presence and feeding of myriads of scale-insects, of which the mango shield-scale (*Coccus mangiferae*) is the most abundant. This insect occurs on several plants other than mango, such as breadfruit, nutmeg, sapodilla and cinnamon.

When the planters learn to recognise the different scale-insects on these trees sufficiently to estimate the amount of damage done by them, and when the conditions of soil and exposure to wind, are considered in relation to the condition of the trees, it will be possible to estimate correctly the injuries resulting from plant pests in a manner not possible while the conditions are all confounded under the general term black blight.

Control of Scale-Insects by Natural Enemies.

Recommendations have been made from time to time with regard to the introduction into Grenada of the natural enemies of scale-insects, principally the entomogenous fungi, as a means of controlling black blight. It is now known that there are in the island many well-established scale-insect parasites, and it is not likely that any good can be accomplished by the importation of fungus parasites from other islands, seeing that the known ones are all present, but a judicious distribution of them from places in the island where they are abundant to others where they are not, may have the effect of checking the scale-insects earlier than would occur by natural spread.

It must be remembered, however, that in those districts where the parasitic fungi do not thrive naturally, it will be necessary to make the introduction year after year, and in addition, to improve the conditions by providing shelter belts, where these are needed.

A feature in the control of scale-insects by natural enemies which should not be lost sight of is this :—Such control never results in complete eradication of the host, and so long as there is a sufficient number of scale-insects present to provide host material for parasites, there will be a sufficient number to provide for the continuation of scale-insects for the growth of black blight.

More judgment should be used in the matter of lopping scale-infested and blighted trees. I saw one very striking instance of indiscriminate lopping. A tree standing by the road-side had just been lopped and the lopped branches still lay upon the ground. The leaves were completely covered with black blight on their upper surfaces, and with the mango shield-scale on the under sides. The scale-insects were thoroughly infested by the shield-scale fungus, every scale having apparently been killed by it. A few yards away another mango tree had been lopped a few months before, and when seen had put out a vigorous growth of shoots and young leaves, which were severely infested with the mango shield-scale. Had the first-mentioned tree been left untrimmed, the fungus would soon have spread to the other and checked the scales, and in the case of its own new growth it would have been protected for some time by the great abundance of fungus on the old leaves ; but the removal of all this fungus-bearing material left the new growth exposed to insect attack without check. If it is a reasonable practice to pin in or tie in a few leaves bearing the fungus as a means of introducing it, how much more effective it must be to have a whole tree full left standing near by. The lopping of scale-infested trees in which there are no fungoid or other natural enemies would be beneficial treatment, but the lopping of trees without regard to the presence of the parasites of the scales and merely because they are covered with black blight is likely to do more harm than good.

The insect parasites of scale-insects are of several kinds. Probably the most useful and the most abundant of these are the hymenopterous parasites, which live inside the scale-insect. When they become adult they escape from the scale through a little hole in the back, and such holes are an indication of their presence and beneficial action.

The great need in Grenada is for the planter and small grower alike to realise the part played by scale-insects, to recognise their fungus parasites, and to know how to look for signs of the insect parasites. This would seem to be a good line of work for the Agricultural Department to carry on and it is certain that with better knowledge of these things the attitude toward black blight will be very much changed.

ON SOME NEW ACARINE PARASITES OF RATS.

By Stanley Hirst.

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Four undescribed mites from rats are dealt with in the present note, one being a new species of *Laelaps* (*Haemolaelaps*), which has a wide distribution, occurring in Ceylon, India, Africa and South America; the three others are larval forms of Trombidiidae, and they are the first parasites of this kind to be collected in India; my best thanks are due to Dr. Nelson Annandale and Mr. F. H. Gravely for their kindness in sending me these interesting Acari. I must also thank Mr. Engel Terzi for his carefully prepared drawings of these species.

Genus Laelaps, C. L. Koch.

Subgenus *Haemolaelaps*, Berlese.

Laelaps nuttalli, sp. nov. (figs. 1, 2).

♀. *Body* fairly long oval, being considerably longer than wide. *Dorsal surface* almost entirely covered by the scutum, but a narrow marginal strip of unprotected

Fig. 1. *Laelaps nuttalli,* Hirst, sp. n., ♀; ventral and dorsal aspects.

integument is visible posteriorly in distended specimens. Hairs at hinder end of body longer than those on the scutum. *Scutum* ornamented with a very fine sculpturing formed of numerous lines, nearly all of which are transverse in direction and

anastomose with one another ; the surface is also rendered somewhat uneven by the minute pits from which the hairs spring. Hairs numerous and mostly rather short, but those on the hinder margin are longer, especially the median pair. Hairs on *ventral surface* few in number and fairly long, but not so long as in *L. hilaris*, C. L. Koch. *Sternal plate* wider than long and with fine linear markings on it, somewhat similar to those present on the scutum ; it is provided with three pairs of long fine hairs. *Genito-ventral plate* rounded off posteriorly and not very wide ; there are five (not six, as figured) transverse lines (similar to those found on the same plate in certain species of the genus *Hypoaspis*), running across its surface and dividing it into six segments, the first being much the largest and furnished with two pairs of hairs, whilst the last is very short and easily overlooked ; in all, there are four pairs of hairs on this plate, and they are long and setiform. There is a very minute platelet on each side of the genito-ventral

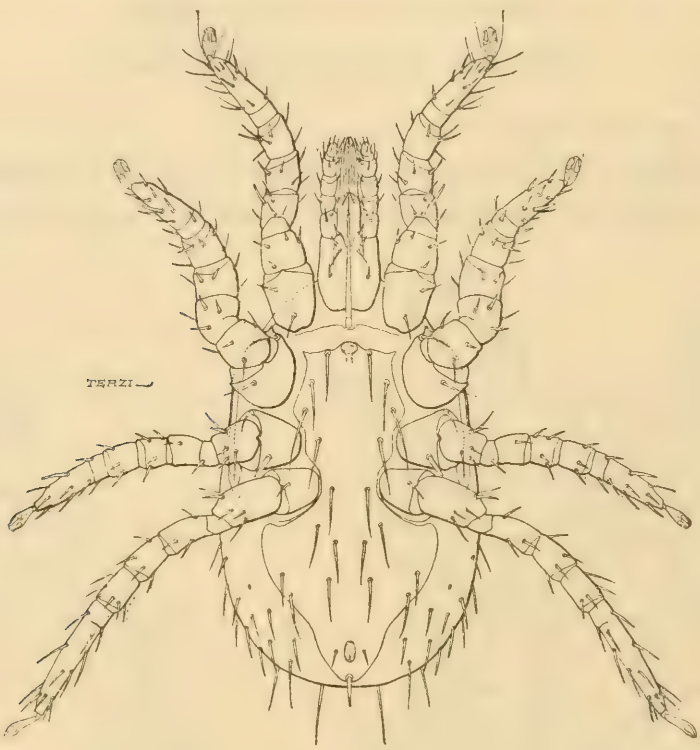

Fig. 2. *Laelaps nuttalli*, Hirst, ♂ ; ventral aspect.

plate, almost opposite the second pair of hairs, and another very similar platelet is situated further outwards (nearer to the last coxa). The usual comma-shaped platelet is present and it is very different in shape from that of *L. hilaris*, being narrow and elongated. *Anal plate* with the anterior margin practically straight, and with the three usual hairs. *Peritreme* apparently extending about as far forwards as the middle of the first coxa. Narrow central groove of the lower surface of the *capitulum* furnished with denticles. *Legs* : first and second legs stout, especially the latter ; the fourth leg is fairly slender and is the longest ; most of the hairs on the legs are rather short and subspiniform, but slender ; there are one or two strong spines on the second tarsus and two or three on the third tarsus, besides the more slender ones ; fourth tarsus furnished with rather slender setae of moderate length. *Colour* (in spirit) pale yellow to deep brown. Length of body ·62 mm.; width ·44 mm.

♂. Style of *chelicera* not very long and very like that of *L. echidninus* in appearance. *Ventral plate* shaped as shown in figure 2; there are eleven pairs of slender setae on it and they are all fairly long, except the last pair; the usual unpaired hair is also present. *Peritreme* apparently almost as long as in the female. *Length* of body ·45 mm.; the width ·27 mm.

CEYLON: Colombo, a number of specimens from *Mus rattus* and *M. norvegicus* (*Dr. L. F. Hirst*) (the types). INDIA: Calcutta, specimens found on *Nesokia* (*Gunomys*) *bengalensis*, 22.iii.15, and on *Mus rattus*, 10.iii.15 (*C. Paiva*). SIERRA LEONE: Freetown, numerous specimens taken on *Mus norvegicus*, xi.1914 (*A. W. Bacot*). DUTCH GUIANA: Paramaribo, a number of examples from *Mus norvegicus*, 27.vii.08; presented to the Quick Laboratory, Cambridge, by the Hon. N. Charles Rothschild, and kindly lent me for examination by Prof. G. H. F. Nuttall, F.R.S.

Dermanyssus muris, Hirst.

Additional locality. Central Formosa (Holst Coll.); host not given.

Genus MICROTHROMBIDIUM, Haller.

Microthrombidium gliricolens, sp. nov. (figs. 3, 4).

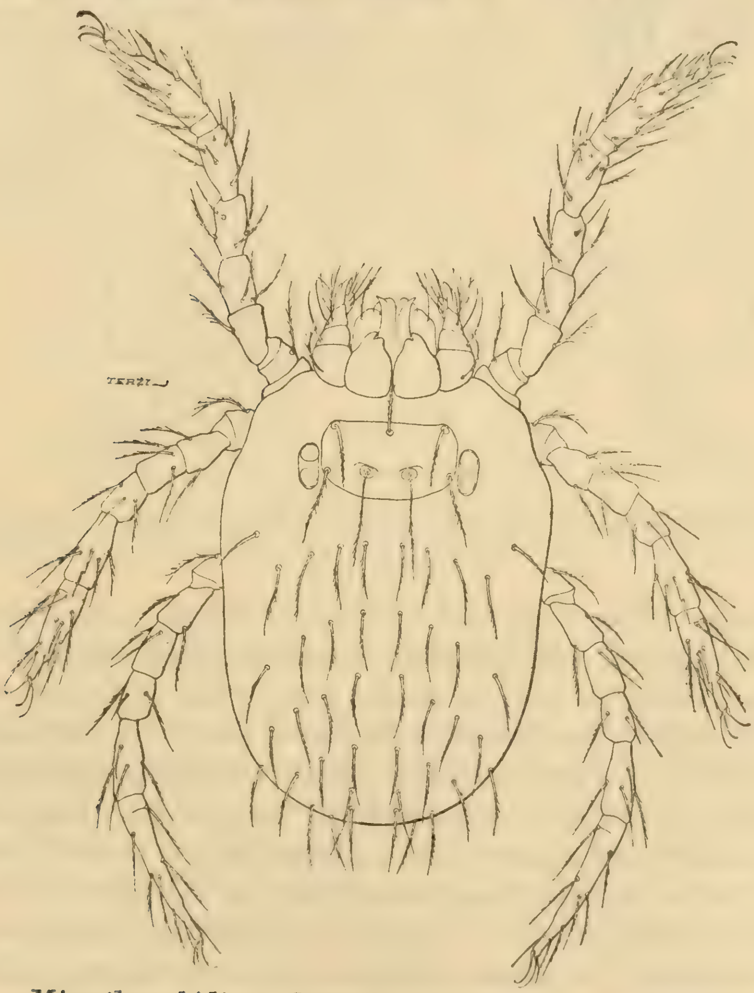

Fig. 3. *Microthrombidium gliricolens*, Hirst, sp. n.; dorsal aspect.

Dorsal surface. Scutum much wider than long (width ·069 mm., length ·04 mm.), its anterior edge straight, but the posterior edge distinctly curved; seven hairs are

present on its surface, the *pseudostigmata*, which are the longest, being placed well behind the middle. Ocular shield normal in appearance; both eyes are present and circular in shape. A little in advance of the middle of the body, there is a transverse row of ten hairs, the outermost hair on each side being situated somewhat in front of the others. Three transverse rows, each consisting of eight hairs, are also present posteriorly on the dorsal surface and a few additional hairs at the extreme hinder end of the body. All the hairs, both on the scutum and on the rest of the dorsal surface are strongly plumose. *Ventral surface.* Coxae each provided with a single hair. Most of the hairs on the lower surface of the body are considerably shorter than the dorsal hairs; but the two anterior pairs of hairs situated between the coxae are long, especially the first pair, and there are some fairly long hairs at the hinder end. *Palp.* Femur with a strongly plumose hair on its dorsal surface; the dorsal hairs on the other segments apparently being plain. Claw forked, the accessory

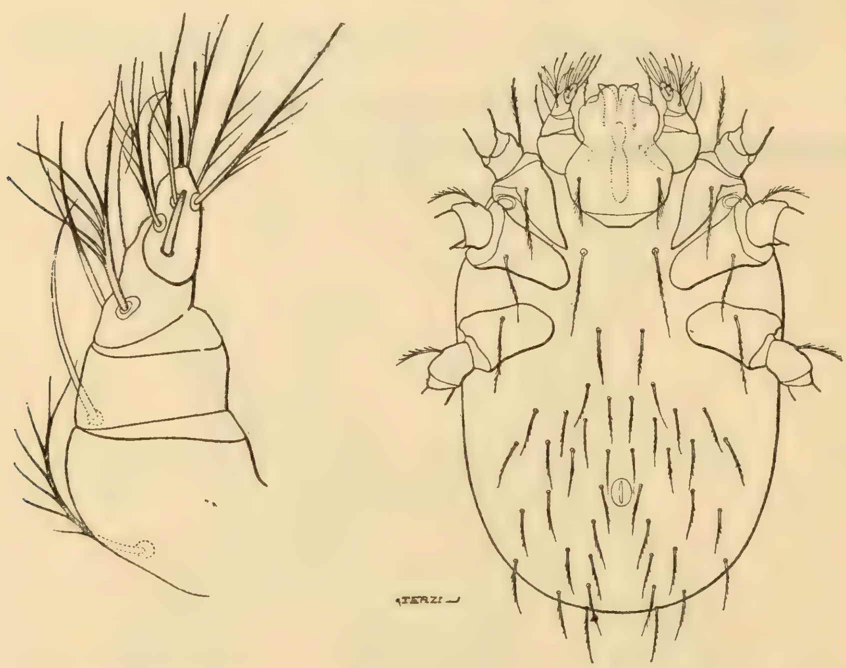

Fig. 4. *Microthrombidium gliricolens*, Hirst; ventral aspect of palp and body.

branch being short. Tarsus furnished with five feathered hairs, and a short rod-like hair near the proximal end, also a little spine near the distal end (fig. 4). *Legs* rather long and slender; furnished with numerous hairs, which are more strongly plumose than those on the body. Besides these feathered hairs, there are also a few rather short hairs or spines on the legs, one being present on the upper surface of the patella of the first and second, and two on the tibiae of these limbs; tarsus of first leg with a rather strong rod-like process above, and a similar, but more slender one on the second tarsus; there is also a very short and minute hair on the tibia and tarsus of the first leg and on the tarsus of the second. A plain subspiniform hair occurs on the patella and tibia of the third leg; tarsus of this limb long, slender and gradually narrowed. *Length* of body ·24 mm.

INDIA: Calcutta, a single example from inner part of ear of *Mus rattus*, 20.iii.15 (*C. Paiva*).

Genus SCHÖNGASTIA, Oudms.

Schöngastia indica, sp. nov. (figs. 5, 6).

Dorsal surface. *Scutum* trapezoidal in shape (width ·053 mm., length ·04 mm.), and furnished with seven hairs (including the pseudostigmata), a hair being present in the middle of the anterior margin ; the hairs of the posterior pair are the longest. *Pseudostigmata* situated slightly in advance of the middle of the scutum ; the stalk is of moderate length and the enlarged end oval (club-shaped). Ocular shield inconspicuous ; the anterior eye oval and well-developed, but the posterior eye obsolete. A hair is situated some distance behind each shoulder in distended specimens, but in examples which are not swollen, this hair is close to and practically forms part of the following transverse series of eight hairs. Behind the middle of the body, there are three transverse series, each of six hairs, and then follows a row of four hairs,

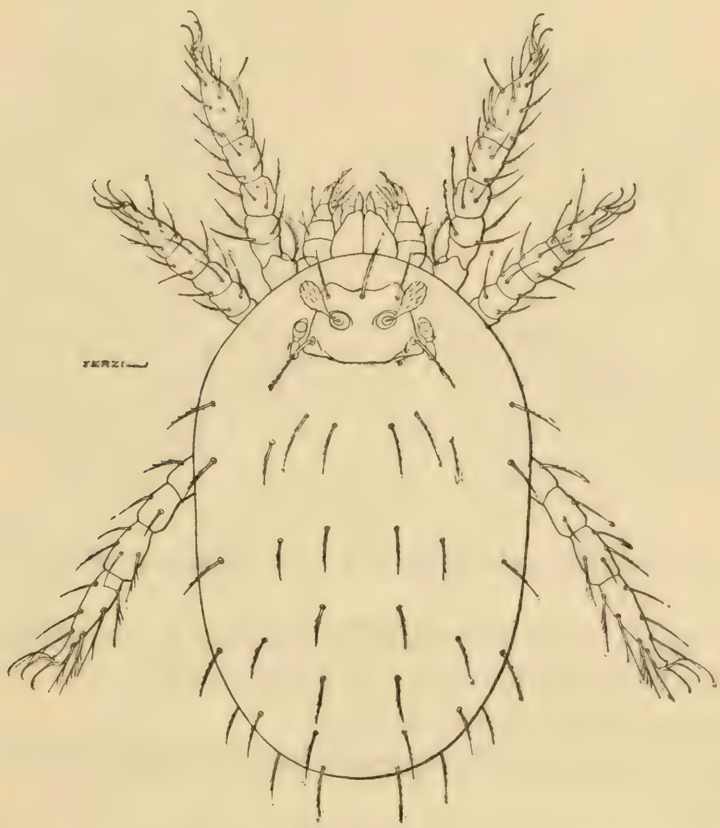

Fig. 5. *Schöngastia indica,* Hirst, sp. n. ; dorsal aspect.

finally a pair of hairs at the end of the upper surface ; all these hairs are fairly long and rather distinctly feathered. Apparently, there is a very slight transverse furrow behind the scutum and a much more distinct furrow or constriction of the body behind the row of eight hairs. *Ventral surface.* Hairs on ventral surface only moderately long and not so distinctly feathered as those on the upper surface of the body ; they are arranged as shown in figure 6. Coxae each with a single long hair, that on the third coxa being very fine. *Palp* with the dorsal hairs only slightly feathered ; tibia with two ventral hairs, one of them very slightly feathered ; claw bifurcated, the accessory branch being short ; tarsus with a little blunt rod-like hair and six (five ?) other longer hairs, four of them being distinctly feathered. *Legs* not very

long ; tarsi of first and second legs abruptly narrowed, especially the former, and the distal end of these segments is very slender. Third tarsus not very long, but gradually narrowed. There are numerous feathered hairs on the legs and the following plain hairs and processes are also present on them :—One of the hairs on the femur of the *first leg* is very long and fine and apparently not feathered ; patella of this limb with two or three plain hairs above ; tibia with two plain setae, one of them being apical and somewhat rod-like and evidently corresponding to the larger rod-like process on the tarsus ; a very minute hair or spine is also present on each of the last three segments of this leg. Hairs on the *second leg* somewhat similar to those on the first ; apparently, there are two plain hairs on the patella and two plain hairs or setae on the tibia ; the rod-like hair on the tarsus is slender and not so much curved as that on the first tarsus ; the very short hair seems to be present only on

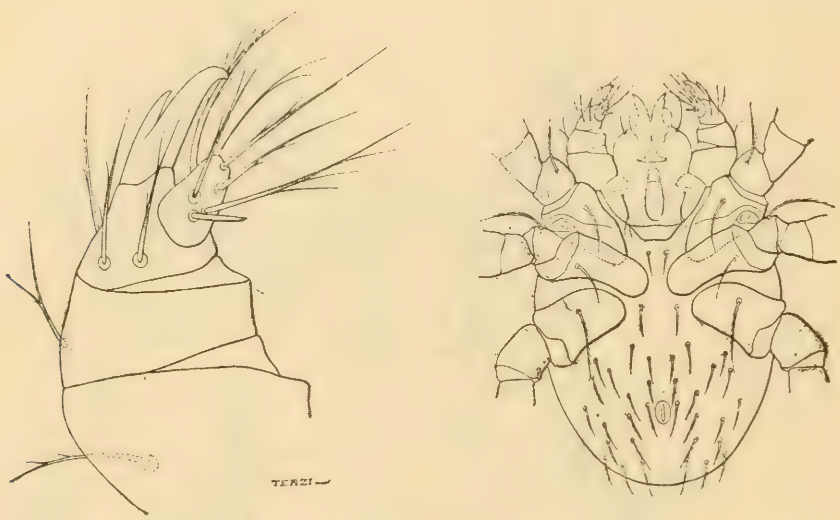

Fig. 6. *Schöngastia indica,* Hirst ; ventral aspect of palp and body.

the tarsus of this limb. Some of the hairs on the *third leg* are plain or inconspicuously feathered, others are distinctly plumose. *Colour* (in spirit) white, sometimes yellowish. *Length* of body (distended specimen) ·325 mm.

INDIA : Calcutta, numerous examples from *Nesokia* (*Gunomys*) *bengalensis,* 22.iii.15 (*C. Paiva*).

SCHÖNGASTIELLA, gen. nov.

The larval form described below has a scutum rather closely resembling that of *Typhlothrombidium,* Oudms., in shape, but furnished with four pairs of hairs instead of five. Ocular shield obsolete, but a distinct circular eye is present on each side in the usual position.

Schöngastiella bengalensis, sp. nov. (figs. 7, 8).

Dorsal surface. Scutum tongue-shaped, being much longer than wide (length ·08, width ·056 mm.) ; it begins to diminish in width near its middle (at the level of the third pair of hairs) and the posterior extremity is bluntly pointed. Numerous very fine punctations are present on the surface of the scutum and there are four pairs of hairs on it, including the *pseudostigmata,* which have the enlarged end practically

spindle-shaped, the stalk being quite short. Ocular shield obsolete and very inconspicuous ; usually only a single distinct circular eye can be seen on each side. A lateral hair is placed on each side of the dorsal surface, almost opposite (slightly behind) the hairs of the third pair on the scutum. Two hairs on each side are placed in a line with the fourth pair on the scutum, so as to make a transverse series of six hairs. Next come three transverse series, each composed of eight hairs ; the outer hair on each side being sometimes placed further back than the others. There are also some hairs at the hinder end of the body. *Ventral surface.* Coxae each with a single hair. Numerous hairs are present on the posterior half of the lower surface of the body and they are arranged as shown in figure 8 ; those near the middle are of small size, but the posterior ones are long ; all are distinctly feathered. Fang of *chelicera* large, curved and very sharply pointed ; it is furnished with a little ventral

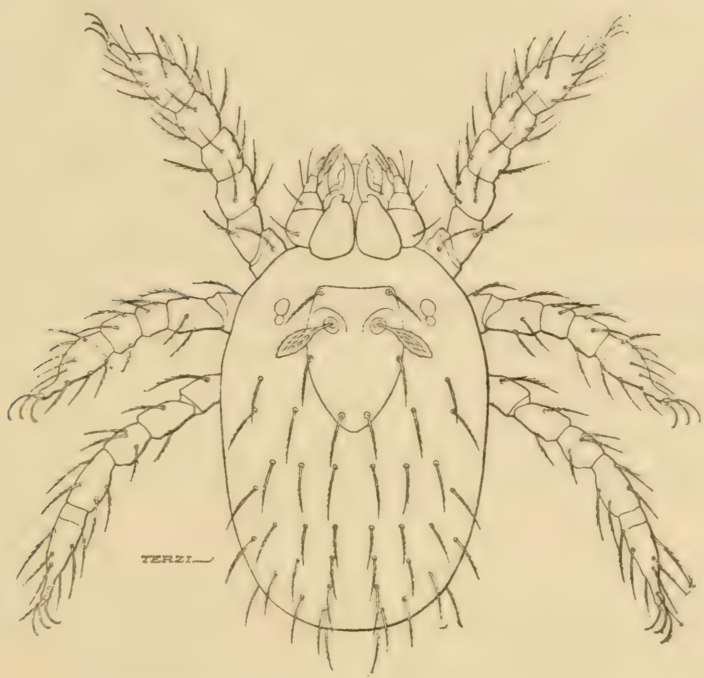

Fig. 7. *Schöngastiella bengalensis,* Hirst, sp. n. ; dorsal aspect.

tooth situated just before the end. *Palp* salient and angular externally ; hairs on its dorsal surface of moderate length and, apparently, they are not feathered ; tibia with only a single ventral hair ; claw forked, the accessory branch small ; tarsus with a little blunt rod-like hair, and four (sometimes only three ?) feathered hairs. *Legs* rather short. Besides the feathered hairs, the following plain hairs are present on the legs :—The patella of the *first leg* has one or two moderately long plain hairs ; tibia dorsally with a plain hair of moderate length and also a slender rod-like apical hair ; tarsus with a fairly stout rod-like hair and the usual stiff hair is present on the summit of the hump ; a very minute hair is also present on each of the three distal segments of this limb. Hairs on *second leg* very similar to those on the first. There is a fine unfeathered hair on the patella of the *third leg* ; the rest of the hairs on the distal segments of this limb apparently are distinctly feathered, some of them

being long, especially those on the tarsus ; third tarsus much less abruptly narrowed than the others, but the terminal portion of it more slender than the rest of the segment. *Colour* (in spirit) white. *Length* of body (distended example) ·44 mm.

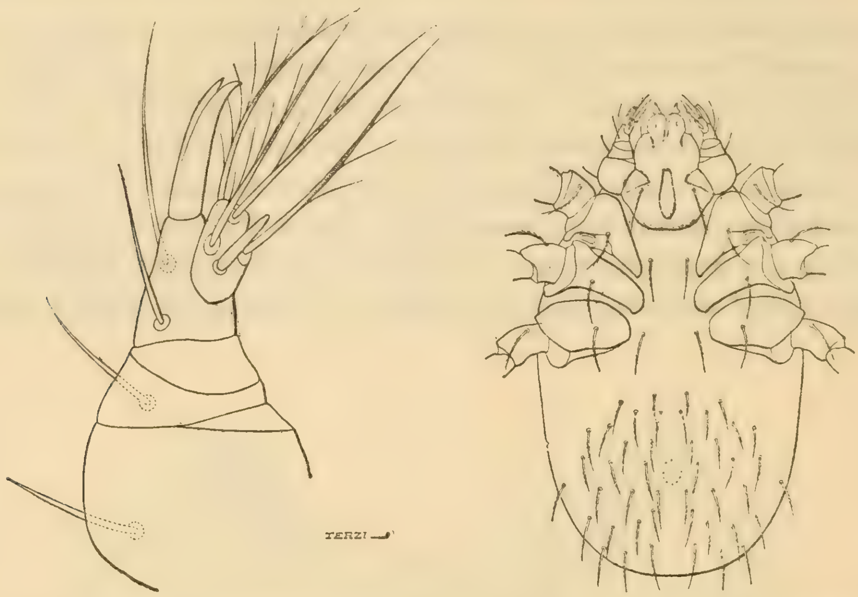

Fig. 8. *Schöngastiella bengalensis*, Hirst ; ventral aspect of palp and body.

INDIA : Calcutta, several specimens from the inner part of the ears of *Mus rattus*, 20.iii.15 (*C. Paiva*).

PRELIMINARY NOTES ON THE LIFE-HISTORY OF ARGAS BRUMPTI, NEUMANN.

By Harold H. King, F.L.S., F.E.S.

(*Government Entomologist, Anglo-Egyptian Sudan ; Wellcome Tropical Research Laboratories, Khartoum.*)

Although it is now some eight years since Neumann described *Argas brumpti* from specimens collected by Dr. Brumpt in Somaliland, comparatively little is known of its biology. Dr. Brumpt found the ticks living in dust under ledges of rock in the dry bed of a stream frequented by porcupines (1). In British East Africa they have been taken by Mr. Scholefield on the Yatta Plains (2) and in the Anglo-Egyptian Sudan they have been recorded by the writer as occurring at Gebelein (3). In 1913 Mr. Cunliffe, working in England, obtained eggs and larvae from specimens sent him from British East Africa, but failed to rear the latter (2). Figures of the adult female appear in the Monograph of the Ixodoidea by Nuttall, Warburton, Cooper and Robinson. The egg and unfed larva have been figured and described by Mr. Cunliffe in The Journal of Parasitology (2).

Gebelein, which, as its name implies, consists of two rocky hills or gebels, is situated on the White Nile about 200 miles south of Khartoum. These hills are sparsely clothed with trees and other vegetation, and contain numbers of caves and crevices. The fauna found on them includes leopards, hyaenas, warthogs, porcupines, honey-badgers, conies, rock pigeons, guineafowl and innumerable bats. The ticks live here among the debris—soil and rotting leaves and twigs—in the crevices between the rocks and in the caves.

A. brumpti was first found at Gebelein in 1909, when nine specimens were taken. No other opportunity of obtaining specimens occurred until August 1913, when the writer and his wife, as a result of two days' search, succeeded in capturing one adult female and 29 nymphs of various sizes. When alarmed the ticks feign death and are then exceedingly difficult to detect, especially in the dim light of the caves. In fact, by merely turning over the debris in which they were living scarcely one was obtained, and the method eventually adopted was that of gently disturbing the debris and then watching. After a short time the ticks would come out towards one to feed, and could then be seen. Of the 30 specimens taken, the adult female and 12 nymphs were put aside for breeding purposes.

The ticks in captivity. No difficulty was experienced in inducing them to feed either on man or a rabbit, even when exposed to strong light. The adult female was given a meal of human blood on 21st August, but after that it was fed on rabbits, together with the nymphs. Eggs were obtained from the female in March and again in April 1914, but all efforts to rear the resulting larvae failed. No more eggs were obtained until October 1914, by which time seven of the nymphs had reached the adult stage, five being females and two males. These females were then isolated, and all received visits from one or other of the two males.

Mating habits. Although pairs of ticks ready to mate were kept under close observation, the act of copulation was not witnessed. Probably it takes place only at night. One male can certainly fertilise at least three females, for, as noted above, five newly matured females were bred from though only two males were available.

Oviposition. The ticks were confined in glass-bottomed pill-boxes containing a little fine dry sand. They spent their time buried in the sand and oviposited in this position. When a batch of eggs had been laid, the female remained over it and, if undisturbed, continued to brood the eggs until they hatched. For this reason it was almost impossible to ascertain when oviposition had ceased without disturbing the female.

Incubation period. The incubation period has not been accurately determined. In one instance it was about 26 days, the first eggs of the batch being laid between 17th and 18th November and the larvae appearing on 13th December.

Larva. A newly hatched larva is feeble and disinclined to move. After two or three days the chitin hardens and the proboscis, palpi and legs, which are at first colourless, acquire a bright chestnut hue. The larva then becomes more active. If breathed upon it becomes excited and runs about, apparently in search of food. Mr. Cottam, who has been in charge of the ticks, states however that they do not feed readily until about 10 days old.

Food of the larva. Attempts were made to feed the larvae obtained in April 1914 on a chick, a nestling sparrow and pigeons. They refused to take any notice of the chick, but attached themselves readily to the sparrow and pigeons. After becoming partially gorged on these hosts however they died, without dropping off. Efforts were made to feed the larvae obtained in November and December 1914 on nestling and adult sparrows, young wild doves and bats, but without success. On the sparrows they would live for several days, but, with one exception, they all die sooner or later. The exception was a larva which remained attached to a fledgling sparrow for nine days, at the end of which time, when it appeared to be almost full-fed, the sparrow escaped. The larvae refused absolutely the wild doves, and only one specimen could be induced to attach itself to a bat—this larva was dead by the following day.

It was thought that probably the guineafowl would prove to be a suitable host for the larvae, but considerable difficulty was experienced in obtaining one. Eventually one was procured through the kindness of Captain Edwardes, A.D.C. to His Excellency the Governor General, and on this bird the larvae fed readily. At first they were placed on the under side of the wing, but only one attached itself. This specimen had disappeared by the following morning. On the loose skin of the head, in the ring of wiry feathers surrounding the ear and among the short feathers on the upper part of the neck however they attached themselves readily.

Nineteen larvae attached themselves to the head of the bird on the 13th December 1914 and thirty more two days later. Twenty-six were recovered between 21st December and 1st January. These larvae were fed on rabbits, and those surviving at the time of writing had taken five meals and moulted four times. The remainder were killed and preserved in various stages of development.

The original stock of 26 gorged larvae recovered from the guineafowl is now represented by one third-stage nymph and five fourth-stage nymphs. More larvae are

being reared. It is the intention of the writer to describe and figure the various stages of *A. brumpti* and to give further details of its life-history when specimens have been reared to maturity. It is hoped that in the meantime these incomplete notes may be of some interest.

The writer was in the provinces from 17th December 1914 till 26th May of this year and during that period the ticks were in the charge of Mr. R. Cottam, Laboratory Assistant.

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SOME NOTES ON THE BIONOMICS OF ORNITHODORUS SAVIGNYI IN BRITISH SOMALILAND.

By R. E. Drake-Brockman, M.R.C.S., L.R.C.P.

In the Somali country this tick is found in the soil in or around the huts on the outskirts of the coastal towns, showing a predilection for the more squalid and insanitary areas where the indigent Somalis reside. In the interior it frequents most camps of long-standing which are inhabited by human beings and their domestic animals. They are extremely common in the dusty soil surrounding the wells and waterholes. In the waterless Haud and the Nogal Valley they are most frequently found under large trees, especially when these are in isolated positions, as at Ged Aboukir on the Arori Plain, and afford the only shade for miles to the shepherd and his flock during the heat of the day.

Ornithodorus savignyi is capable of living for months without a fill of blood in the soil, into which it burrows to a depth of half to one inch, lying dormant there until the ground is disturbed by the foot of man or beast. In captivity it will live for six months and more in a tightly-stoppered bottle half-filled with dry earth, without food or water. It will attack human beings, camels, cattle, ponies, mules, donkeys, sheep and goats with equal vigour.

When the soil in which it lives has been disturbed, it will move rapidly over the surface until it finds its victim, losing as little time as possible before it starts to feed. It seldom climbs much higher than the ankles in human beings and the hocks in animals.

The actual time occupied by the tick in getting its fill of blood varies, according to its size, from 20 to 45 or even 60 minutes. As soon as it is engorged with blood and just previous to withdrawing its biting apparatus, it discharges a fluid per anum which moistens the skin in the vicinity of the puncture. On withdrawal this fluid enters the wound and is doubtless the cause of the subsequent irritation, which varies in different individuals. In some cases the area of the irritation may be the size of a half-crown piece or more.

Various methods have been suggested for destroying these ticks, but little of any practical value can be done owing to their wide distribution. In confined areas where they swarm, such as the immediate vicinity of wells, the best and cheapest method to adopt is to cover the whole infested area with dry grass and brushwood, after harrowing or disturbing the surface, and then setting fire to the grass all round simultaneously so that the fire will gradually burn its way towards the centre.

Spraying the ground with various antiseptics has been suggested, but this method is not only costly but quite useless, as, experimenting with several strong solutions, I have found total immersion of the ticks for an hour and more quite ineffective—the poison having little or no effect on them. After an immersion lasting two hours of a number of half- and full-grown ticks in solutions of 1 in 500 carbolic acid and

corrosive sublimate, I have found the ticks alive and active. Immersion in a 5 per cent. solution of lysol for half an hour however seems to have a deleterious action on them, some dying, though others recovered after a prolonged rest. Thus it will be seen that mere spraying the soil or even soaking it is quite useless.

If *Ornithodorus savignyi* is touched with a drop of oil of turpentine it at once dies, and I have taken advantage of this fact to recommend all native soldiers with bare feet, when entering a locality where the ticks are known to swarm and are infected with the spirochaete of relapsing fever, to rub their feet and ankles with turpentine, and I consider this likely to prove a valuable prophylactic measure.

The Somali name for the tick is " kudkudeh " or " kudkuda."

NOTES ON A THRIPS INJURIOUS TO VINES IN CYPRUS.

By Z. G. Solomides,

Entomologist to the Department of Agriculture, Cyprus.

This insect, which is being described by Mr. R. Bagnall under the name of *Cryptothrips brevicollis*, sp. n., has been known to vine-growers in Cyprus for at least ten years, but was believed to be harmless, and the damage it actually effected was attributed to other causes, *e.g.*, fungus, unsuitable soil, bad cultivation, or faulty methods of planting. A fortnight's study on the spot during August last convinced me that the injury from which these vines were suffering was not due to any of these causes. A careful examination of roots, leaves, branches, grapes and flowers revealed no fungoid disease. Nor was the attack due to defective soil or imperfect planting or cultivation, as the same characteristic attack was seen on the vines of the Departmental Model Vineyard at Omodhos where the soils had been most thoroughly cultivated and the vines had been carefully planted and skilfully tended. The vine owners whose vines were found thus attacked called the disease "Caraoli," which means "curling," a condition brought about by the action of the vine thrips.

This insect has three generations, and between April and the middle of September it attacks all the more tender parts of the vine. The eggs are laid in the buds or near the base of the opening tender leaves. The larvae on hatching out attack these by cutting or scraping the epidermis and sucking the juices. The buds are not wholly destroyed and are often capable of developing, though not naturally, as the distances between the joints of the stems are shortened and the leaves borne on them, as well as those which are directly attacked, are curled and bear spots of varying sizes where the under surface of the epidermis has been gnawed by the thrips. The nymphs and adults continue to injure the foliage upon the branches where the attack is localised, the plants meanwhile putting forth other branches.

When the insects have completed the destruction in one place, they commence a similar attack elsewhere. Some gnaw the petioles or stalks of leaves or buds, near the base, checking their growth and causing curling. When they are numerous all the first buds and small branches are nearly destroyed and fresh ones are then formed. By the time the insects have multiplied greatly and arrive on the fresh branches, these latter have developed and only their most tender leaves are liable to be damaged.

At the time of flowering the insects mate and lay eggs on the tendrils near the flowers or on the leaves, and then begin their attack either on the flowers, the stamens and pistils of which are destroyed, or on the newly set grapes. The injury, according to my observations, is usually limited to two or three clusters. The others develop, but are in turn attacked at a later stage.

The mode of attack is as follows :—The insect scrapes or bites the skin of the grape ; it then dips its beak vertically into the pulp and absorbs the juices. If it is not satisfied with the spot chosen, it withdraws its beak and immediately attacks another part of the grape. I have observed that two minutes after a thrips has withdrawn

its beak a faint black spot is formed, and when an insect remained for some time with its beak dipped in the pulp, on its withdrawal a deep black spot was visible. In 2–4 days this becomes a clear coffee-colour, and later on, it assumes a cork-like appearance and projects beyond the skin surface. This scab can be easily detached by the finger nail, and microscopical examination shows that it is not the outer skin of the grape, but is composed of dead tissue or pulp. I have found that the tissue was destroyed to a depth of about 15 mm., and all the cellules and tissue of the pulp round the part affected were of a yellowish coffee colour.

These scabs vary in shape and size, as also the number of them found on a grape. I have noticed 10 larvae on one grape quietly sucking the juice. Grapes so attacked either do not develop, or they dry up ; when more lightly attacked they develop, but owing to the presence of these spots, they are disfigured and are unsaleable. In serious attacks 50 per cent. of the fruit may be spoilt. In cases such as these, the flow of the sap is interfered with, and we may find new flowers and small grapes appearing in July and August ; these furnish fresh food for the 2nd and 3rd generations of the insects.

I have observed no attack on any of the woody parts of a vine or on the roots. No vine attacked by this insect was found by me with diseased roots. This furnishes additional proof that the damage to the plants was caused by the insects.

The insect appears when the vine puts forth the first buds and leaves, and eggs are then laid on the leaves or opening buds. Hatching takes place in 2–5 days. Vines attacked early present a more injured appearance than do those which are attacked only after the formation of the first shoots. In the latter stage the insect finds the leaves and shoots rather hard and the rostrum cannot do so much damage. This is the first generation and it appears in April. The second generation occurs in May and June, when the damage is equally serious, because all the insects attack the flowers and the young fruits. Up to 90 per cent. of the fruit on a vine may be injured, the insects attacking cluster after cluster in turn. When they have completed their attack upon one vine they proceed to another. Often many plants together are found so damaged. Elsewhere again the attack is confined to isolated plants ; this often being due to the insects having been carried by wind. When this is so, we often find that in the following year the attack is not so serious as in the first year. The attack of this second generation lasts up till the first days of August, when the third generation appears. This generation occurs throughout August and continues until the falling of the leaves. Then the adults hibernate in the crevices of the main stem, in the side branches, or in the ground, until the following April, when again the first generation appears and renews the life-cycle.

I have noticed different Acari as parasites on *Cryptothrips brevicollis*, but owing to pressure of other work I have not studied them.

The following preventive measures are recommended :—

1. Clear the vines from weeds ; collect and burn all leaves, or let them be consumed by stock. This gets rid of a large number of insects.

2. Clear the old bark from the main stems and burn it ; apply a 15 per cent. lime wash to these stems. Possibly 80–90 per cent. of the insects hibernating there would thus be killed.

3. Deep ploughing or digging is very important, as thereby a large number of insects may be buried.

When the crop is already affected, the treatment recommended is to spray the vines when the first shoots appear, about April, with $1\frac{1}{2}$ oke* of quassia chips and 27 drams of Paris green in 100 okes of water. Repeat the spraying when the flowers approach the time of opening in May.

A NEW VINE THRIPS (THYSANOPTERA) FROM CYPRUS.

By Richard S. Bagnall, F.L.S.

I have been asked by the Director of the Imperial Bureau of Entomology to report upon, and, if necessary, describe a thrips which has been discovered to be distinctly injurious to vines in Cyprus. Two curious species of the suborder Terebrantia have been described from vines, viz., *Retithrips aegypticus*, Marchal, from Egypt and *Rhipiphorothrips bicolor* (Bagnall) from Ceylon, and Karny and Doctor van Leeuwen Reijnvaan record the following gall-thrips of the suborder Tubulifera from vines in Java ; *Dolerothrips picticornis*, Karny, with an inquiline (*Cryptothrips pachypus*, Karny) from *Vitis papillosa, Gynaikothrips viticola*, Karny, from *V. lanceolaria* and a gall (species unknown) from *V. mutabilis*.

Two specimens mounted on one slide have been submitted. Though apparently of the same species, one of these possesses perfectly formed antennae of but 7 joints, the comparative lengths of the joints differing from the corresponding joints in the specimen with 8-jointed antennae. Further, the reduction in the number of joints cannot be said to be due to the fusion of any two joints. I describe the 8-jointed form and should welcome further material.

The species apparently belongs to the genus *Cryptothrips* of the *nigripes*, Reut.,—*major*, Bagn., group. I say " apparently " advisedly, as I should have referred it to the allied genus *Gynaikothrips* but for the fifth antennal joint being so nearly subequal with the sixth and markedly shorter than the fourth. Apart from antennal characters, this species differs markedly from *G. viticola* in the shorter head, the very short prothorax and the coloration of the hind and intermediate tibiae.

Suborder Tubulifera.

Cryptothrips brevicollis, sp. nov.

♀. Colour brown to blackish brown ; fore tibia yellow, greyish brown basally, and all tarsi yellow ; hind and intermediate tibiae yellow distally. Antennae with basal joint concolorous with head, 2 yellowish distally, 3 lemon yellow, 4–7 yellow, the latter

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* 400 drams = 1 oke = $2\frac{3}{4}$lb.

tinged with grey distally, and 8 light grey-brown. Tube somewhat lighter brown in apical half. Wings clear, cilia grey-brown.

Head 1·2 times as long as broad across hind margin of eyes and more than twice as long as the pronotum ; cheeks straight, parallel or slightly divergent posteriorly. Eyes small, finely facetted, occupying laterally about one-fourth the length of head. Vertex roundly raised, with the fore ocellus at apex, directed forwards. Post-ocular bristles set well back, blunt. Mouth-cone pointed, reaching across prosternum. Antennae twice as long as the head ; relative lengths and breadths of joints 3–8 as follows :—

70 : 64 : 52 : 50 : 44 : 13
22 : 25 : 22 : 22 : 20 : 6,

3 and 4 claviform, 5 and 6 fusiform, 7 weakly fusiform, inclined to be cylindrical, 8 obpyriform.

Pronotum strongly transverse, about 2·5 times as broad as long ; all setae present, blunt, those at posterior angles and postero-marginal pair longest, 0·7 to 0·8 the length of pronotum ; the mid lateral pair longer than those on anterior margin. Pterothorax large, quadrate ; wings reaching to abdominal segment 8 and fore-wing with about 13 duplicated cilia. Legs slender, fore tarsus unarmed.

Abdomen elongate-ovate, broader than the pterothorax, broadest at segment 5 and thence gently narrowing to 9. Tube a little more than 0·8 the length of head, about 1·7 times as wide at base as apex, about 2·4 times as long as wide at base ; terminal hairs slender, pale, about 0·6 the length of tube. Abdominal bristles almost colourless to pale yellow ; those on 9 slender, about 0·8 the length of tube ; a longish pair on 7.

CYPRUS (*Z. G. Solomides*).

BEETLES BORING IN AERIAL CABLES.

Mr. C. P. Lounsbury, Chief of the Division of Entomology, Union of South Africa, has forwarded the following note from the Postmaster-General of the Union with regard to damage done by beetles to aerial cables :—

"Lead-covered aerial cables, containing wires insulated by means of paper, are used largely by this Department for telephone distribution purposes. An examination of one of these cables at Yeoville resulted in the discovery of a clean-cut hole about one-eighth of an inch in diameter. A small section of the cable was cut out and a beetle was found inside the cable immediately behind the hole in the lead sheath. . . . . This is the second beetle discovered, and in both instances the hole was bored at a point in the cable sheath immediately underneath the marline suspender, by which the cable is attached to the suspending wire. This seems to indicate that the marline is likely to harbour these insects, and that having made a comfortable nest therein the boring operations are commenced. Very few of our cables are suspended with marline, the usual practice being to utilise galvanised iron rings through which the cable is threaded ; with these no trouble has been experienced."

Mr. Lounsbury states that the specimen submitted to him was damaged, but that it was a Bostrychid and probably *Sinoxylon ruficorne*, Fhs. It seems likely that in these cases the beetles were really attracted to the rope suspenders and that the boring of the cable was merely an accidental consequence.

The Postmaster-General adds the following quotation from an electrical journal :— "In Shanghai there is a curious flying insect which is able to bore holes in which to lay its eggs in the lead covering of overhead cables, but the author knows of no case in a tropical country where an insect has damaged an armoured lead-covered cable."

Similar damage to aerial cables has been reported from Hong Kong, Queensland and the Argentine. In the Queensland case the insects were discovered and proved to be also Bostrychids, of two species, *Bostrychopsis jesuita*, F., and *Xylopertha* sp.

Lesne (Ann. Soc. Ent. France, lxix, 1900 (1901), p. 591, *note*) quotes a record of another Bostrychid, *Scobicia pustulata*, boring in gas-pipes in Europe.

COLLECTIONS RECEIVED.

The thanks of the Imperial Bureau of Entomology are due to the following gentlemen, who have kindly presented collections of insects (received between 1st January and 31st March, 1915) :—

Mr. T. J. Anderson, Government Entomologist :—2 *Pangonia*, 1 *Haematopota*, 36 other Diptera, 10 Hymenoptera, 2 Coleoptera, 37 Lepidoptera, 1 Caddis-fly, and 10 Rhynchota ; from British East Africa.

Mr. E. Ballard, Government Entomologist :—15 Diptera, 7 Coleoptera, and 9 Lepidoptera ; from Coimbatore, South India.

Mr. O. Barker Benfield :—1 Longicorn beetle ; from Accra, Gold Coast.

Mr. G. E. Bodkin, Government Economic Biologist :—1 *Chrysops*, 2 *Dichelacera*, 5 *Tabanus*, 13 other Diptera, 11 Ants, 209 other Hymenoptera, 13 Coleoptera, 1 Moth and its pupa case, 2 other Lepidoptera, 25 Anoplura, 339 Termites, 187 Mallophaga, 13 Rhynchota, 7 Orthoptera, 2 Centipedes, 8 Millipedes, about 100 Mites, 1 Spider, 1 Scorpion, and 2 tubes of Worms ; from British Guiana.

Mr. E. C. Chubb, Curator of the Durban Museum :—96 Culicidae, 1 *Haematopota*, 33 *Tabanus*, 7 *Stomoxys*, 2 Oestrid larvae, 3 other Diptera, and 90 Rhynchota ; from South Africa.

Dr. J. Burton Cleland, Principal Microbiologist, New South Wales :—46 Tabanidae ; from Australia.

Mr. d'Emmerez de Charmoy, Government Entomologist :—125 imagines, 4 pupae, and 20 larvae of Moth pests, with examples of damage done by them ; from Mauritius.

Mr. G. Ievers Cree :—2 imagines, 2 pupae, and 1 larva of the Dynastid beetle *Heteronychus licas*, Klug, injuring sugar-cane ; from Zululand.

Dr. J. B. Davey, M.O. :—140 Culicidae, 6 *Chrysops*, 1 *Haematopota*, 16 *Tabanus*, 1 *Cordylobia*, 1 Hippoboscid, 223 other Diptera, 83 Hymenoptera, 40 Coleoptera, 38 Lepidoptera, 1 Caddis-fly, 2 Planipennia, 29 Rhynchota, and 6 Orthoptera ; from Zomba, Nyasaland.

The Director of Agriculture, Cyprus :—2 vine Thrips (*Cryptothrips brevicollis*, Bagn., sp. n.) ; from Cyprus.

Division of Entomology, Pretoria :—54 Diptera, 141 Coleoptera, and examples of damage done to beans by beetles, 2 *Chrysopa*, 38 Rhynchota, and 23 Orthoptera ; from the Transvaal.

Mr. R. A. F. Eminson :—A series of Hymenopterous parasites of *Glossina morsitans*, viz., the Mutillid, *Mutilla glossinae*, Turn., sp. n., and the Chalcidoids, *Stomatoceras micans*, Waterst., sp. n., and *Syntomosphyrum glossinae*, Waterst., sp. n. ; from Northern Rhodesia.

Mr. E. Ernest Green :—6 species of named Coccidae.

Mr. Gerald F. Hill, Government Entomologist :—8 *Tabanus*, 2 larvae and 2 pupae of *Dacus*, 221 other Diptera, 46 Siphonaptera, about 500 Ants and 32 other Hymenoptera, 26 Coleoptera, 6 Lepidoptera, 32 Trichoptera, about 50 Mallophaga, 15 species of Coccidae, 53 other Rhynchota, 15 Orthoptera, 5 Odonata, 9 Thysanura, 1 Spider, and 6 Centipedes ; from the Northern Territory, Australia.

Mr. Rupert W. Jack, Government Entomologist :—15 Moths ; from Rhodesia.

Mr. F. P. Jepson, Government Entomologist :—about 70 Mosquitos ; from Fiji.

Mr. Ll. Lloyd, Government Entomologist :—4 *Haematopota*, 1 *Tabanus*, and 13 specimens of the Chalcidoid *Anastatus viridiceps*, Waterst., bred from puparium of *Glossina morsitans* ; from Northern Rhodesia.

Mr. C. Mason, Government Entomologist :—17 Hymenoptera, 53 Lepidoptera and 18 Coleoptera ; from Nyasaland.

Mr. J. C. Moulton, Curator of the Sarawak Museum :—151 Mosquitos ; from Sarawak.

Mr. W. H. Patterson, Government Entomologist :—Examples of damage done by the bug *Sahlbergella* to cacao branches ; from the Gold Coast.

Mr. W. F. Poulton, Veterinary Officer, Uganda :—6 Moths (*Arcyophora longivalvis*, Guen.) attacking eyes of Mules ; from Kukuha, German East Africa.

Mr. A. Rutherford, Government Entomologist :—39 Culicidae, 35 other Diptera, 33 Hymenoptera, 65 Coleoptera, 52 Lepidoptera, 8 Thrips, 67 Aphids, 17 other Rhynchota, 2 Orthoptera, and 1 Spider ; from Ceylon.

Dr. H. S. Stannus, M.O. :—2 *Chrysops*, 2 *Haematopota*, 15 *Tabanus*, 3 Asilids and prey, 256 other Diptera, 178 Hymenoptera, 433 Coleoptera, 8 Lepidoptera, 4 Planipennia, 493 Rhynchota, 9 Odonata, 1 Stone-fly, 32 Orthoptera, and 1 Spider ; from Zomba, Nyasaland.

Dr. A. T. Stanton, Government Bacteriologist :—27 Culicidae, 12 slides of early stages of Culicidae, and 8 other Diptera ; from the Federated Malay States.

Mr. F. W. Urich, Government Entomologist :—2 Coleoptera and 1 species of Coccid ; from Trinidad.

Mr. Robert Veitch :—13 Hymenoptera, 48 Coleoptera, 24 Lepidoptera, 1 tube of Aleurodidae, 1 tube of Coccidae, and 28 other Rhynchota, 3 Odonata, 3 Orthoptera, and 2 Spiders ; from Fiji Islands.

The Wellcome Bureau of Scientific Research :—about 50 Chicken mites ; from Colombia.

Dr. John Y. Wood, W.A.M.S. :—23 Culicidae, and about 100 larvae, 7 *Haematopota*, 3 *Tabanus*, 76 *Glossina*, 1 *Auchoneromyia* larva, 3 other Diptera, 1 Flea, 1 Cimicid bug, and 1 Anopluran ; from Sierra Leone.

Mr. Rodney C. Wood : 1 *Thriambeutes*, 1 *Cadicera*, 16 *Haematopota*, 52 *Tabanus*, 1 Hippoboscid, 10 other Diptera, 1 Weevil, 2 Rhynchota, 2 Ticks, and 1 Spider ; from Chiromo, Nyasaland.

VOL. VI. Part 3.—pp. 205-312.

DECEMBER, 1915.

BULLETIN OF ENTOMOLOGICAL RESEARCH

ISSUED BY THE IMPERIAL
BUREAU OF ENTOMOLOGY.

EDITOR: THE DIRECTOR.

LONDON:

SOLD BY

DULAU & Co., Ltd., 37, SOHO SQUARE, W.

Price 4s. net.

IMPERIAL BUREAU OF ENTOMOLOGY.

HONORARY COMMITTEE OF MANAGEMENT.

OBSERVATIONS ON THE BIONOMICS OF STEGOMYIA FASCIATA.

By J. W. Scott Macfie, M.A., D.Sc.,

West African Medical Staff.

The life-history and habits of *Stegomyia fasciate* have of course been most carefully studied. On looking through the literature at my disposal, however, I was unable to ascertain certain points with regard to the feeding and breeding of individuals that I was anxious to know, and I therefore undertook some experiments myself to determine these. A few notes on my observations may perhaps be of interest to others, and my excuse for recording them must be the importance of even the most trivial details in the life of the insect responsible for the spread of yellow fever. The experiments were all made under similar conditions, and as it was found possible to rear many successive generations of *Stegomyia fasciata* under these conditions, it is perhaps justifiable to suppose that the habits of the insects were not greatly affected. It is impossible to make such observations under absolutely normal conditions, and it may be doubted whether any closer approximation to the natural state that is compatible with close observation would materially improve the results. It should be stated clearly that the experiments relate only to *Stegomyia fasciata*. The habits of other species of even the same genus, as for example those of *Stegomyia metallica* with which I have had an opportunity of working, are notably different.

Stegomyia fasciata is, fortunately for the experimenter, but unfortunately for the sanitarian, exceedingly easy to breed. In the laboratory in any sort of jar or tin, and in all sorts of fluids, the larvae received from the sanitary inspectors matured, pupated, and hatched into adults ; and if feeds of blood were provided, no difficulty was experienced in obtaining eggs and further generations of larvae. Not only did the mosquitos breed readily when kept together in large numbers, but single individuals and pairs did not appear to be affected in any way by isolation. This was fortunate, as it was my object to study the habits of individuals, and this would have been practically impossible had it been necessary to deal with large numbers of mosquitos in each experiment.

In each experiment a single female was isolated with, or sometimes without, one or two males. Only recently hatched mosquitos were employed, that is, such as had emerged from pupae on the same days as the experiments were started. The mosquitos were placed in a roomy glass jar, at the bottom of which there was a layer of water, and over the mouth of which a piece of gauze was tied. An arch of folded paper was fixed in the middle of the jar for the insects to rest on, and on the upper surface of this drops of honey were laid. The jars were changed frequently, and fresh honey was supplied almost daily. For the purposes of the experiments the bared forearm was applied at various hours of the day or night to the gauze coverings of the jars, and allowed to rest there for ten minutes. This was found to be ample time for the mosquitos to feed if they wished to do so. At the end of this time the mosquitos were examined, those that had fed being readily identified by the bright

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blood visible through the walls of the abdomen. It was necessary for me to feed the insects on my own blood, and it should therefore be mentioned that throughout the period of the experiments I was taking five or ten grains of quinine daily.

Length of Life.

No true estimate of the natural length of life of mosquitos can be expected from laboratory experiments, for the insects are on the one hand protected from their natural enemies, and screened from exposure, but on the other hand they are confined to a restricted space, and in the case of the males are fed on an unnatural diet. In my experiments none of the mosquitos reached the age limits recorded for this species by other observers. The males lived relatively short lives, the longest noted being only 28 days; and the females, although they survived somewhat longer, did not in a single instance live beyond the 62nd day. Patton and Cragg (1913)* state that "The female can be kept alive for many months, and in nature can probably survive for at least six months," but as the conditions determining the length of natural life must be very complex this must be at best an intelligent guess. It was noticed in my experiments that several females showed marked signs of senescence after they had laid a number of batches of eggs. The evidences which I interpret as being those of senility were diminished activity, and reduction of the powers of flight. Mosquitos that had been under observation a long time became very lethargic. They were often noticed to remain resting in the same position all day, and were with difficulty roused. When forcibly disturbed they responded only by crawling slowly to another part of the jar. Towards the ends of the experiments they appeared to be incapable of flight, and either crawled about laboriously, or sometimes made little jumps as though they wished to fly but were unable to do so. If water was in the jars the loss of the power of flight led to the mosquitos falling on to its surface, and being unable to extricate themselves. It was necessary sometimes to guard against this by replacing the water by damp blotting paper, as it was found the insects might survive in this condition for a considerable time (see Expt. No. vi). In nature they would probably have fallen an easy prey to natural enemies long before such pronounced senile changes had developed. The rapidity with which one batch of eggs followed another, as well as the actual number laid, appeared to be important. For instance the female in experiment No. iii. which laid fifteen batches at intervals of about three days died on the 50th day, but that in experiment No. ii. which laid only ten batches at rather longer intervals survived until the 60th day.

Blood Feeding.

The male *Stegomyia fasciata* feeds on honey only. He can, however, live at least ten days in jars containing nothing but water (see Expt. No. viii), and is able to fertilise the female without taking any nourishment. The female also feeds on honey during the first day or two of her imaginal life, and if blood feeds are denied her may continue to survive on this diet for a long time. Goeldi is quoted by Boyce (1911)† as having succeeded in keeping a female alive on honey for 102 days. But under normal conditions it must be very exceptional for a mosquito such as *Stegomyia fasciata*,

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* Patton, W. S., and Cragg, F. W., "Medical Entomology," p. 217.

† Boyce, Sir R. W., "Yellow Fever and its Prevention," p. 287.

which breeds in the immediate vicinity of human dwellings, to be unable to obtain a feed of blood for more than a day or two at a time ; and it is improbable that she is ever called upon in nature to subsist for long on honey alone, even if it is a fact that she does sometimes naturally drink nectar. When blood is obtainable it would seem that this is the chief food of the female mosquitos, although in the course of my experiments it was sometimes noticed that they appeared to have fed on honey between their blood feeds.

In those experiments, for example Nos. i. and ii., in which an opportunity of feeding on blood was afforded at least twice a day from the time of emergence from the pupal state, the females fed for the first time on the second, or more often the third day, and did not feed again until after the first batch of eggs had been laid. For the rest of their lives they fed regularly once, but only once, soon after each batch of eggs had been laid ; and as the eggs were generally laid every third or fourth day, the blood feeds also took place every third or fourth day. There were of course slight irregularities in the habits of the individual mosquitos, but a careful examination of the details of the experiments that are given below will show that the above statements are justified. An unfertilised female, however, behaved differently (see experiment No. viii). In her case, although blood feeds were taken, they did not occur at such regular intervals, and no eggs were laid.

After it had once been ascertained by a large number of observations that the mosquitos never fed on blood excepting just after a batch of eggs had been laid, it was considered unnecessary to continue to offer the arm for feeding twice every day unless some particular object were in view. Instead, as in experiment No. iii., the arm was offered after each batch of eggs had been laid until the mosquito fed, and then was not offered again until after the next batch had been laid. This simplification could not, I think, have had any effect on the course of the experiments ; and in any case it was not resorted to until after the general habits of the mosquitos had been thoroughly studied in a number of experiments.

A good deal of interest has been expressed in the hours during which *Stegomyia fasciata* feeds on blood, owing to the belief that yellow fever is transmitted at night time only. In my experiments it was found that the mosquitos at all ages might feed at any hour, the time depending on the time at which the eggs had been laid. In the majority of cases the eggs were found in the early morning or in the evening, and the mosquitos were generally ready to feed very soon after the last egg had been deposited They would not, however, feed during the period when they were actually depositing their eggs. Thus the mosquitos whose eggs had been found in the early morning were ready to feed on blood at the first opportunity afforded during the succeeding day, and those that had laid their eggs in the afternoon or evening fed the same night. It did occur sometimes that a female that had laid her eggs early in the morning refused to feed on blood until the following evening ; and on the whole in the experiments it was found that a larger proportion of the opportunities of blood feeding were taken advantage of at night than in the day.

If the conditions of the experiments had not greatly modified the habits of the mosquitos, we must conclude that the female *Stegomyia fasciata* in nature sets out in search of blood as soon as she has finished laying each batch of eggs, and that she is almost equally likely to bite by day or night. There was no evidence that, as has

been suggested, the mosquitos after their first feed bite only during the hours of twilight or in the dark. From individual cases, such as experiment No. ii., some such conclusion might have been drawn ; but a careful examination of the whole series showed that it would have been quite inaccurate.

In the case of the initial feed it might have been supposed that a preference for some particular hour would have been shown, since this feed precedes the laying of the first eggs. It was found, however, that the mosquitos took this first meal of blood sometimes by daylight, sometimes in the dark ; in the early morning, in the middle of the day, or at night, and that no preference seemed to be evinced for any particular hour. In one experiment (No. viii) an unfertilised female was kept for 35 days. During this time she fed on blood ten times, and on each occasion at night.

Ovulation.

The first batch of eggs was generally laid on the sixth or seventh day ; that is three or four days after the first meal of blood. The actual number of eggs laid in each batch varied greatly, sometimes about a hundred being deposited, sometimes as few as seven. The majority of the batches were found in the early morning, between 6 and 7 a.m., the hour at which the mosquitos were first looked at each day. As by this time the mosquitos were as a rule ready to feed on blood, it is probable that they had finished laying their eggs some little time previously. Over fifty per cent. of the eggs laid in the course of the experiments were deposited before 8 a.m. If the eggs were not laid at this time they were generally found in the evening or late afternoon.

After the first blood feed the females were found to lay their eggs at regular intervals up to, or almost up to, the day of death, provided that they had previously been fertilised, and that every opportunity was given them of feeding on blood whenever they wished. Each batch of eggs was laid three or four days after each blood feed. Under such circumstances the number of batches of eggs laid depended on the length of the life of the mosquito. One female of my series laid fifteen batches in her life of 50 days ; but as it is recorded that *Stegomyia fasciata* may live much longer than this there seems no reason to suppose that a much larger number may not sometimes be attained. The statement made by Boyce (1911) that " The average number of separate batches of eggs laid by a single female may be given as two to three, but that as many as nine batches have been laid in some cases " is certainly an underestimate.

In order that eggs may be laid it is necessary that the female should be first fertilised, and then allowed a meal of blood. An unfertilised female lays no eggs, although she may feed on blood repeatedly. This fact is illustrated by experiment No. viii., in which an unfertilised female fed on blood ten times during 35 days, but laid no eggs. The mosquito, however, retained her power to lay eggs ; and after a male had been introduced into the jar in which she was confined, she laid, on the 43rd and 45th days of her life, eggs from which larvae hatched a few days later. It has been shown by Goeldi that fertilised eggs may lie dormant in the female for as long as 102 days, and may then be laid if a feed of blood is allowed ; and experiments Nos. iv. and v. show the same postponement for shorter periods. It is clear therefore that both fertilisation and blood are necessary to the female for ovulation. But it is not necessary that fertilisation should take place immediately before or after the blood feed. In experiment No. vi. fertile eggs were laid 24 days after the last male had

died, and in another experiment carried out by me a female continued to lay fertile eggs up to the date of her death 37 days after the last possible date of fertilisation. The details of this experiment are not included here, as they have already been published in the Annual Report of the Laboratory, Accra, for the year 1914.

The blood feed must follow fertilisation. It is not the same thing if the meal of blood precedes fertilisation as is shown by experiment No. vii. In this experiment a newly hatched and unfertilised female *Stegomyia fasciata* was isolated and allowed to feed on blood. This she did on the third day. The next day two males were introduced into the same jar, and fertilisation took place immediately. Nevertheless no eggs had been laid up to the tenth day, when a second feed of blood was permitted, although the subsequent history of the mosquito showed that under the conditions provided she laid her eggs regularly on the third day after each blood feed.

In nature it probably happens occasionally that the female *Stegomyia fasciata* fails to procure a meal of blood immediately she is ready for it. The effect of such a delay is exemplified in experiment No. vi. The mosquito in this case laid her first batch of eggs on the sixth day of her adult life, on the third day after her first blood feed, and her second batch on the ninth day at a similar interval after the second feed. Her third batch of eggs was therefore due on the twelfth or thirteenth day. But instead of allowing her to feed on blood on the ninth day immediately after she had laid her second batch of eggs, she was prevented from doing this until the eleventh day. Her third batch of eggs was laid on the fifteenth day, that is two days late, but on the fourth day after the last blood feed. The effect of delaying the blood meal was therefore simply to delay the laying of the next batch of eggs a corresponding number of days. In experiments Nos. iv. and v. the mosquitos were prevented from feeding on blood for the first ten and seventeen days of their adult lives respectively. The only noticeable effect of this deprivation was that the total number of batches of eggs laid was reduced by the numbers that might have been expected to have been laid during these periods of blood starvation.

Temperature.

It was thought that possibly the lowering of the temperature might have something to do with the slight preference that seemed to be shown by the mosquitos for feeding at night. Two experiments (Nos. ix. and x.) were therefore carried out to determine the effects of a high temperature on *Stegomyia fasciata*.

In each of the experiments newly hatched mosquitos were isolated in glass jars under the same conditions as in the other experiments, but the jars were kept in an incubator at 37° C (98·6° F) excepting during two periods of about half an hour at 8–9 a.m. and 2–3 p.m. each day, when they were removed so as to give the mosquitos an opportunity of feeding on blood. The mosquitos were incidentally in darkness also for the greater part of each day.

The high temperature did not obviously inconvenience the mosquitos; both males and females were active, drank honey readily, and paired frequently. They did not survive long, however; the five males lived only 4, 3, 8, 1, and 9 days respectively, and the two females 18 and 11 days. In the case of the females other effects were observed. The second female (experiment No. x) did not feed on blood

at all, and the first (experiment No. ix) fed only twice in eighteen days. No eggs were laid in either experiment.

A temperature of 37° C (98·6° F) would therefore appear to have the effect of shortening the life, diminishing the blood-sucking propensities, and destroying the fertility of *Stegomyia fasciata*.

Summary.

So far as could be determined from laboratory experiments the sequence of events relating to blood feeding and the laying of eggs in the life of *Stegomyia fasciata* was found to be as follows :—

On the second or third day after emergence from the pupa the mosquito takes her initial feed of blood. If she has previously been fertilised she lays her first batch of eggs on the sixth or seventh day, and is ready to feed again on blood a few hours later. Thereafter she lays eggs regularly every third or fourth day, and feeds on blood once only after each batch is laid in preparation for the next batch. The female continues to lay batches of eggs throughout her life, and in this way at least fifteen may be deposited. In order that eggs may be laid at all, both fertilisation and a meal of blood are required, and it is necessary that the fertilisation should precede the blood feed. Once fertilised, the female may continue to lay batches of fertile eggs for at any rate 37 days without being reimpregnated. If the eggs are laid in the early morning, she feeds during the day-time; if in the afternoon or evening, she feeds at night; but sometimes she refuses an offer to feed in daylight in favour of the next opportunity to feed in the dark.

Table I.

The relationship between ovulation and blood feeding in five experiments each with a single female Stegomyia fasciata.

Experiment No. I.		II.		III.		IV.		V.	
Day on which eggs laid.	Day on which fed on blood.	Day on which eggs laid.	Day on which fed on blood.	Day on which eggs laid.	Day on which fed on blood.	Day on which eggs laid.	Day on which fed on blood.	Day on which eggs laid.	Day on which fed on blood.
	3		2		3		Starved of blood for 10 days.		Starved of blood for 17 days.
7	8		9	5 & 6	6				
11	13	16	15	9	9				
19	19	19	19	12	12		11		
23	23	23	23	15	15	15	15		
27	27	27	28	18	18	18	18		18
30	32	31	32	21	21	21	21	21	21
35	36	35	35	24	24		24	24	25
39	40	39	39	26	26	27	27	28	28
43		43	43	29	29	30		30	30
Died 43rd	on the day.	47		32	32	Died 30th	on the day.	32	32
			56	34 & 35	35			34	34
		60		37	37			36	36 & 37
		Died 60th	on the day.	40	40			40	40
				43	43			43	43
				46	46			45	
				Died 50th	on the day.			Died 45th	on the day.

Details of ten of the experiments upon the biology of Stegomyia fasciata.

The temperatures recorded are those registered daily by a maximum and minimum thermometer hung in the room in which the glass jars containing the mosquitos were kept.

Abbreviations: "R." = the female mosquito refused to feed on blood.
"Fed" = the female mosquito fed on blood.
"—" = no opportunity of feeding on blood was given.

Experiment No. I.

13th January 1915. One female *Stegomyia fasciata*, hatched to-day, isolated in a glass jar under the usual conditions. Three males added, one hatched to-day, and two hatched yesterday.

Date.	Range of temperature.	Arm offered at Daylight, 1–2 p.m.	Arm offered at Dark, 8–9 p.m.
Jan. 13	79–83° F.	R.	R. Female had fed on honey.
,, 14	76–84	R.	R.
,, 15	75–84	R.	Fed.
,, 16	76–84	R.	R.
,, 17	76–84	R.	R.
,, 18	78–83	R.	R.
,, 19	79–84	R.	R. Eggs laid this evening—Batch I.
,, 20	79–83	R.	Fed.
,, 21	76–84	R.	R.
,, 22	74–86	R.	R.
,, 23	71–81	R.	R. A few eggs found this evening—Batch II.
,, 24	75–83	R.	R.
,, 25	74–84	R.	Fed.
,, 26	76–84	R.	R.
,, 27	75–86	R.	R.
,, 28	76–84	R.	R.
,, 29	80–84	R.	R.
,, 30	76–83	R.	R.
,, 31	79–83	Fed. A few eggs found this morning—Batch III.	R.
Feb. 1	79–84	R. One male dead.	R.
,, 2	78–84	R.	R.
,, 3	73–85	R.	R.
,, 4	74–83	Fed. Eggs found this morning—Batch IV.	R.
,, 5	76–84	R. One male dead.	R.
,, 6	78–84	R.	R.
,, 7	76–84	R.	R.
,, 8	77–84	Fed. Eggs found this morning—Batch V.	R.
,, 9	79–83	R. Last male dead.	R. A freshly hatched male introduced at 4 p.m.
,, 10	79–83	R.	R.
,, 11	79–84	R.	R. A few eggs found this evening—Batch VI.
,, 12	80–84	R.	R.
,, 13	80–84	R.	Fed
,, 14	81–85	R.	R.
,, 15	80–85	R.	R.

EXPERIMENT No. I.—*cont.*

Date.	Range of temperature.	Arm offered at Daylight, 1–2 p.m.	Arm offered at Dark, 8–9 p.m.
Feb. 16	80–84	R.	R. Eggs found to-night—Batch VII.
„ 17	81–85	R.	Fed.
„ 18	79–85	R.	R.
„ 19	80–86	R.	R.
„ 20	79–85	R.	R. Eggs being laid at 8–9 p.m.—Batch VIII.
„ 21	80–86	Fed.	R.
„ 22	80–85	R.	R.
„ 23	81–87	R.	R.
„ 24	81–87	R. Eggs found this morning—Batch IX.	Female found dead on the surface of the water in the jar.

EXPERIMENT No. II.

12th January 1915. A single female *Stegomyia fasciata* hatched at 2 p.m. and immediately isolated in a glass jar under the usual conditions. Mosquito therefore unfertilised. Refused to feed on my arm at 3 p.m., and again at 9 p.m.

Date.	Range of temperature.	Arm offered at Daylight, 1–2 p.m.	Arm offered at Dark, 8–9 p.m.
Jan. 13	79–83° F.	R.	Fed.
„ 14	76–84	R.	R.
„ 15	75–84	R.	R.
„ 16	76–84	R.	R.
„ 17	76–84	R.	R.
„ 18	78–83	R.	R.
„ 19	79–84	R.	R. A single newly hatched male introduced; paired immediately.
„ 20	79–83	Fed slightly.	Fed again, fully.
„ 21	76–84	R.	R.
„ 22	74–86	R.	R.
„ 23	71–81	R.	R.
„ 24	75–83	R.	R.
„ 25	74–84	R.	R.
„ 26	76–84	R.	Fed.
„ 27	75–86	R. Eggs found this morning—Batch I.	R.
„ 28	76–84	R.	R.
„ 29	80–84	R.	R.
„ 30	76–83	R. A few eggs found this morning—Batch II.	Fed.
„ 31	79–83	R.	R.
Feb. 1	79–84	R.	R.
„ 2	78–84	R.	R.
„ 3	73–85	R. Eggs found this morning—Batch III.	Fed.

Experiment No. II.—*cont.*

Date.	Range of temperature.	Arm offered at Daylight, 1–2 p.m.	Arm offered at Dark, 8–9 p.m.
Feb. 4	74–83	R.	R.
,, 5	76–84	R.	R.
,, 6	78–84	R.	R.
,, 7	76–84	R. A few eggs found this morning—Batch IV.	R.
,, 8	77–84	R.	Fed.
,, 9	79–83	R.	R.
,, 10	79–83	R.	R.
,, 11	79–84	R.	R. A few eggs found this evening—Batch V.
,, 12	80–84	R.	Fed.
,, 13	80–84	R.	R. Male dead.
,, 14	81–85	R.	R.
,, 15	80–85	R.	Fed. Eggs found this evening—Batch VI.
,, 16	80–84	R.	R.
,, 17	81–85	R.	R.
,, 18	79–85	R.	R.
,, 19	80–86	R. Eggs found this morning—Batch VII.	Fed.
,, 20	79–85	R. Newly hatched male introduced.	R.
,, 21	80–86° F.	R.	R.
,, 22	80–85	R.	R.
,, 23	81–87	R. Eggs found this morning—Batch VIII.	Fed.
,, 24	81–87	R.	R.
,, 25	78–86	R.	R.
,, 26	80–84	R.	R.
,, 27	80–86	R. Eggs found this morning—Batch IX.	R.
,, 28	78–85		R. Female remained settled in one place all day.
Mar. 1	78–85	R.	R. Female could hardly be made to move.
,, 2	80–84	R.	R. Female practically immovable.
,, 3	79–85	R.	R. ditto.
,, 4	80–85	R.	R. ditto.
,, 5	80–85	R.	R. ditto.
,, 6	80–85	R.	R. ditto.
,, 7	82–86	R.	R. ditto.
,, 8	81–87	R.	Fed.
,, 9	81–87	R.	R.
,, 10	81–87	R.	R.
,, 11	81–86	R. A fresh male added; the old one still alive.	R. Female down on surface of water in jar.
,, 12	80–86	At 8 a.m. the female was found dead on the water; there were about 10 eggs present—Batch X.	

Experiment No. III.

25th February 1915. A male and a female *Stegomyia fasciata*, hatched to-day, isolated in a glass jar under the usual conditions.

Date.	Range of temperature.	Arm offered at Daylight, 1–2 p.m.	Arm offered at Dark, 8–9 p.m.
Feb. 25	78–86° F.	—	R.
„ 26	80–84	R.	R.
„ 27	80–86	Fed.	—
„ 28	78–85	—	—
Mar. 1	78–85	—	R. Some eggs found this afternoon—Batch IA.
„ 2	80–84	R.	Fed. Some more eggs found this evening—Batch IB.
„ 3	79–85	—	—
„ 4	80–85	—	—
„ 5	80–85	R. A few eggs laid between 8 a.m. and 1 p.m.—Batch II.	Fed.
„ 6	80–85	—	—
„ 7	82–86	—	—
„ 8	81–87	—	Fed. Eggs found this afternoon—Batch III.
„ 9	81–87	—	—
„ 10	81–87	—	—
„ 11	81–86	Fed. Eggs found this morning between 6 and 7 a.m.—Batch IV.	—
„ 12	80–86	—	—
„ 13	82–87	—	—
„ 14	82–88	Fed. Eggs found this morning at 6–7 a.m.—Batch V.	—
„ 15	82–87	—	—
„ 16	80–86	—	—
„ 17	77–87	Fed. Eggs found this morning at 6–7 a.m.—Batch VI.	—
„ 18	80–85	—	—
„ 19	82–87	—	—
„ 20	81–87	Fed. Eggs found this morning at 6–7 a.m.—Batch VII.	—
„ 21	78–86	—	—
„ 22	79–86	—	Fed. Eggs found this evening—Batch VIII.
„ 23	80–87	—	—
„ 24	80–87	—	—
„ 25	80–88	R. A few eggs found at 1 p.m.	Fed. More eggs present by 4 p.m.—Batch IX.
„ 26	82–89	—	—
„ 27	80–89	—	—
„ 28	78–87	Fed. Eggs found this morning at 6–7 a.m.—Batch X.	—

EXPERIMENT No. III.—*cont.*

Date.	Range of temperature.	Arm offered at Daylight, 1–2 p.m.	Arm offered at Dark, 8–9 p.m.
Mar. 29	80–85° F.	—	—
„ 30	78–86	—	R. Seven eggs laid between 8 and 9 p.m.—Batch XI. Male dead.
„ 31	80–83	Fed. More eggs present by 7 a.m.	—
April 1	79–85	—	—
„ 2	81–85	—	Fed. No eggs at 6 p.m. Eggs found at 7.30 p.m.—Batch XII.
„ 3	78–85	— Newly hatched male added.	—
„ 4	77–84	—	—
„ 5	78–85	—	Fed. Eggs laid between 2 and 5 p.m.—Batch XIII.
„ 6	80–86	—	—
„ 7	80–84	—	—
„ 8	79–82	—	Fed. Six eggs laid between 5 and 6 p.m.; twenty-three more before 6.30 p.m.—Batch XIV. No more eggs by 8 p.m.
„ 9	80–84	—	—
„ 10	80–85	—	—
„ 11	79–82	—	Fed. Three eggs laid between 1 and 2 p.m.; at 4 p.m. no more, but over twenty present at 6 p.m.; no more at 8 p.m.—Batch XV.
„ 12	78–84	—	—
„ 13	80–85	—	—
„ 14	81–85	— Female found on the water in the jar this morning, and rescued.	— Female very feeble, but still alive.
„ 15	81–85	— Much the same.	Female found dead in the evening.

EXPERIMENT No. IV.

Feb. 24.—A male and a female *Stegomyia fasciata*, hatched this afternoon, isolated in a glass jar under the usual conditions, but fed only on honey.

March 1.—Male dead; replaced by another newly hatched male.

„ 4.—Male dead; replaced by another newly hatched male.

„ 6.—7–8 a.m. Arm offered for the first time; female fed on blood immediately.

„ 10.—7–8 a.m. Eggs found this morning—Batch I. Arm offered; female fed at once.

„ 13.—7–8 a.m. Eggs found this morning—Batch II. Arm offered; female fed at once.

„ 16.—7–8 a.m. Eggs found this morning—Batch III. Arm offered; female fed, but not very fully. Male died.

Experiment No. IV.—*cont.*

March 19.—10 p.m. Female fed fully. No eggs to-day.

„ 22.—7–8 a.m. Eggs found this morning—Batch IV. Female refused to feed; again refused at noon. 8–9 p.m. Female fed.

„ 24.—A freshly hatched male added.

„ 25.—1–2 p.m. A few eggs found—Batch V. Female refused to feed. 8 p.m. Female found dead on the water in the jar.

N.B.—For the temperatures during this experiment see Experiments Nos. II & III.

Experiment No. V.

March 4.—One female *Stegomyia fasciata,* just hatched, and one male hatched on 28th February isolated in a glass jar under the usual conditions. Fed only on honey.

„ 8.—Male dead: replaced by another, newly hatched.

„ 21.—Male dead: replaced by another, newly hatched. 7–8 a.m. Arm offered for the first time; female fed.

„ 24.—Eggs laid this evening between 5 and 7.30 p.m.—Batch I. 7.30 p.m. Female fed fully.

„ 27.—Eggs laid between 6 and 8 p.m.; more laid later—Batch II. 8–9 p.m. Female refused to feed on my arm.

„ 28.—7 a.m. Female fed fully at once.

„ 31.—7 a.m. Eggs found this morning—Batch III. Female fed fully.

April 2.—No eggs at 8 p.m., but eight found at 9 p.m.—Batch IV. 9 p.m. Female fed on my arm.

„ 3.—7 a.m. No more eggs laid.

„ 4.—7 a.m. A few eggs present—Batch V. Female fed.

„ 6.—Nine eggs laid between 2 and 4 p.m.; no more by 8 p.m.—Batch VI. 8–9 p.m. Female fed.

„ 8.—Eggs found at 7 a.m.—Batch VII. 12–1 p.m. Female refused to feed on my arm. 8–9 p.m. Fed slightly.

„ 9.—8–9 p.m. Fed more fully.

„ 12.—1–2 p.m. Female refused to feed on my arm. No eggs at 6 p.m.; nine or ten at 7 p.m., and a few more by 8 p.m.—Batch VIII. 8–9 p.m. Female fed.

„ 15.—Eggs laid between 4 and 6.30 p.m.—Batch IX. 8–9 p.m. Female fed.

„ 16.—Female very feeble; fell into the water at the bottom of the jar, but was rescued.

„ 17.—6–7 a.m. Eleven eggs found—Batch X, and the female, dying, beside them. Female died in the afternoon.

N.B.—For the temperatures during this experiment see Experiments Nos. II & III.

Experiment No. VI.

10th April 1915. Two males, and one female, *Stegomyia fasciata*, hatched to-day, placed in a glass jar under the usual conditions.

Date.	Range of temperature.	Arm offered at: Daylight, 1–2 p.m.	Arm offered at: Dark, 8–9 p.m.
April 10	80–85° F.	R.	R. One male dead.
" 11	79–82	R.	R.
" 12	78–84	R.	Fed.
" 13	80–85	—	—
" 14	81–85	—	
" 15	81–85	R. Eggs found this morning at 6–7 a.m.—Batch I.	Fed.
" 16	82–86	—	—
" 17	81–85	—	—
" 18	82–86	— Eggs found this morning at 6–7 a.m.—Batch II.	— Mosquito due to feed to-day, but no opportunity given.
" 19	81–86	—	—
" 20	76–81	Fed. Opportunity to feed given to-day, two days late. The mosquito availed herself of it immediately.	—
" 21	78–85	—	—
" 22	77–85	—	—
" 23	80–84	R.	R.
" 24	80–85	R. A few eggs found this morning at 6–7 a.m.—Batch III.	R.
" 25	80–85	Fed. More eggs found this morning at 6–7 a.m.	—
" 26	80–84	—	—
" 27	79–84	—	—
" 28	79–84	—	—
" 29	80–85	Fed. Eggs found this morning at 6–7 a.m.—Batch IV.	—
" 30	76–84	—	—
May 1	75–82	—	—
" 2	76–83	—	—
" 3	76–83	Fed. Eggs found this morning at 6–7 a.m.—Batch V.	—
" 4	78–82	—	—
" 5	78–80	—	—
" 6	78–82	—	—
" 7	77–83	Fed. Eggs found this at morning 6–7 a.m. Batch VI. Male dead. No male now present.	—
" 8	78–83	—	—
" 9	78–83	—	—
" 10	78–83	—	Fed. Eggs found at 4 p.m.—Batch VII.

EXPERIMENT No. VI.—*cont.*

Date.	Range of temperature.	Arm offered at Daylight, 1–2 p.m.	Arm offered at Dark, 8–9 p.m.
May 11	78–84° F.	—	—
„ 12	79–83	—	—
„ 13	79–83	—	—
„ 14	78–84	Fed. Eggs found this morning at 6–7 a.m.—Batch VIII.	—
„ 15	77–82	—	—
„ 16	78–83	—	—
„ 17	79–85	Fed. Eggs found this morning at 6–7 a.m.—Batch IX.	—
„ 18	80–85	—	—
„ 19	79–83	—	—
„ 20	80–84	R. Eggs found this morning at 6–7 a.m.—Batch X.	Fed.
„ 21	80–84	—	—
„ 22	77–83	—	—
„ 23	77–83	—	—
„ 24	77–83	R. Eggs found this morning at 6–7 a.m.—Batch XI.	R.
„ 25	79–83	R.	R. Drinking honey.
„ 26	77–82	Fed.	— Female getting feeble.
„ 27	75–80	—	— Sitting in one place all the day.
„ 28	77–80	—	—
„ 29	79–83	—	—
„ 30	78–82	R. Five eggs found this morning—Batch XII. These eggs, laid 24 days after the last male died, were fertile, and hatched on June 2nd.	R. A few more eggs.
„ 31	76–82	Fed.	—
June 1	77–80	—	—
„ 2	77–81	— Mosquito very feeble.	—
„ 3	76–81	— „ „ „	—
„ 4	77–83	— „ „ „	R.
„ 5	75–81	R. „ „ „	R.
„ 6	77–81	R. „ „ „	R.
„ 7	78–82	R. „ „ „	R.
„ 8	78–82	R. „ „ „	R.
„ 9	77–82	R. „ „ „	R.
„ 10	77–81	R. Mosquito only just alive.	Dead at 4 p.m.

Experiment No. VII.

24th April 1915. Unfertilised female *Stegomyia fasciata*, hatched to-day from a pupa isolated for the purpose, introduced into a jar under the usual conditions.

Date.	Range of temperature.	Arm offered at 1–2 p.m.	Arm offered at 8–9 p.m.
April 24	80–85° F.	—	R.
,, 25	80–85	R.	R. Distended with honey.
,, 26	80–84	Fed.	—
,, 27	79–84	— Two males introduced at 12 noon. Pairing took place at once.	—
,, 28	79–84	—	—
,, 29	80–85	—	—
,, 30	76–84	—	—
May 1	75–82	—	—
,, 2	76–83	—	—
,, 3	76–83	Fed.	—
,, 4	78–82	—	—
,, 5	78–80	—	—
,, 6	78–82	—	Fed. Eggs were laid between 2 & 4 p.m.—Batch I.
,, 7	77–83	—	—
,, 8	78–83	—	—
,, 9	78–83	—	No eggs at 2 p.m. Eggs found at 4 p.m.; probably jut laid, as they were still white—Batch II.

Experiment No. VIII.

30th April 1915. One female *Stegomyia fasciata*, hatched to-day, isolated under the usual conditions. This female was unfertilised, having never been in the same jar as any male.

Date.	Range of temperature.	Arm offered at 1–2 p.m.	Arm offered at 8–9 p.m.
April 30	76–84° F.	R.	R.
May 1	75–82	—	R.
,, 2	76–83	R.	Fed.
,, 3	76–83	R.	R.
,, 4	78–82	R.	R.
,, 5	78–80	R.	R.
,, 6	78–82	R.	Fed.
,, 7	77–83	R.	R. Distended with honey.
,, 8	78–83	R.	Fed.
,, 9	78–83	R.	R.
,, 10	78–83	R.	R.
,, 11	78–84	R.	Fed.

Experiment No. VIII.—*cont.*

Date.	Range of temperature.	Arm offered at	
		1–2 p.m.	8–9 p.m.
May 12	79–83	R.	R.
,, 13	79–83	R.	Fed.
,, 14	78–84	R.	R.
,, 15	77–82	R.	Fed.
,, 16	78–83	R.	R.
,, 17	79–85	R.	R.
,, 18	80–85	R.	R.
,, 19	79–83	R.	R.
,, 20	80–84	R.	Fed slightly.
,, 21	80–84	R.	R.
,, 22	77–83	R.	R.
,, 23	77–83	R. A male *S. metallica* introduced at 11 a.m.	R.
,, 24	77–83	R.	R.
,, 25	79–83	R.	R.
,, 26	77–82	R.	Fed slightly.
,, 27	75–80	R.	Fed slightly.
,, 28	77–80	R.	R.
,, 29	79–83	R.	R.
,, 30	78–82	R.	R.
,, 31	76–82	R.	Fed.
June 1	77–80	R.	R.
,, 2	77–81	R.	R.
,, 3	76–81	R.	R.
,, 4	77–83	R. Male *S. metallica* removed. Pairing had never been observed to take place. A male *S. faciata* put in instead. This mosquito had only hatched this morning, and had had no opportunity of feeding. Honey removed from the jar, so that male has only water to drink.	Fed slightly.
,, 5	75–81	R.	R.
,, 6	77–81	R.	R.
,, 7	78–82	R.	Fed slightly.
,, 8	78–82	R.	R.
,, 9	77–82	R.	R.
,, 10	77–81	R.	R.
,, 11	76–80	R. A very few eggs (5 or 6) this morning.	Fed.
,, 12	76–83	R.	R.
,, 13		More eggs this morning. These eggs, and those laid on June 11 were fertile, and hatched into larvae on June 16th.	

Experiment No. IX.

27th March 1915. A female and a male *Stegomyia fasciata*, just hatched, isolated in a glass jar under the usual conditions, but placed in the incubator at 37° C. The mosquitos were therefore kept also in the dark, except when taken out for the purpose of offering them my arm for feeding.

Date.	Arm offered at 8–9 a.m.	Arm offered at 2–3 p.m.
March 27	R.	R.
,, 28	R.	R.
,, 29	R.	R.
,, 30	R.	R. Fresh male added, as original one sick. He died later in the day.
,, 31	R.	R.
April 1	R. Male dead: replaced by another.	R.
,, 2	R.	R.
,, 3	Fed.	—
,, 4	—	—
,, 5	—	—
,, 6	—	R.
,, 7	—	—
,, 8	R. Male dead.	R.
,, 9	R.	R.
,, 10	R. Newly hatched male added.	R.
,, 11	R.	Fed slightly. Male dead.
,, 12	—	R.
,, 13	Female dead.	

Experiment No. X.

16th April 1915. One male and one female *Stegomyia fasciata*, just hatched, isolated under the usual conditions, but kept in the incubator at 37° C, and incidentally in the dark, except when taken out to be offered blood feeds from my arm. Pairing was observed repeatedly, and both mosquitos evidently drank honey frequently.

Date.	Arm offered at 8–9 a.m.	Arm offered at 2–3 p.m.
April 16		R.
,, 17	R.	R.
,, 18	R.	R.
,, 19	R.	R.
,, 20	R.	R.
,, 21	R.	R.
,, 22	R.	R
,, 23	R.	R.
,, 24	R. Male dead.	R. Newly hatched male added.
,, 25	R. Female feeble and fell into the water in the jar. Rescued.	R.
,, 26	Female dead.	

Inbreeding of Stegomyia fasciata.

On 4th March 1915 a number of mosquito larvae were obtained from a hollow in a tree, the majority of which proved to be *Stegomyia metallica*. As this species had not previously been found in Accra, and as it was apparently one of the rarer species in West Africa, I was anxious to obtain a large number of specimens, and determined to attempt to breed the mosquito in the laboratory. Some doubt was felt about the success likely to attend the experiment, for it seemed probable that all the larvae originally obtained had been hatched from eggs laid by the same mother, and they might therefore have proved to be infertile, or but slightly fertile, when bred together. As a matter of fact, the adult *Stegomyia metallica* mosquitos when isolated in pairs in glass jars did not breed, or did so only occasionally; but when kept together in larger numbers they bred freely. The strain is still in existence, and even now, after five months of inbreeding, appears to be as fertile as ever.

The question as to whether mosquitos hatched from the same batch of eggs would be fertile when bred together was not, however, answered by this experience with *S. metallica*, as it was not known how many females had laid eggs in the hollow in the tree in which the larvae were found. But as individual pairs of *S. metallica* bred with such reluctance when isolated, experiments on these lines could not be carried out with this species. *S. fasciata* on the other hand is very readily bred in captivity, and its habits do not seem to be affected by isolation. The two following experiments were therefore carried out to determine whether males and females of this species that had hatched out from eggs laid in the same batch by the same mother mosquito were capable of breeding together and producing fertile eggs.

> Experiment XI. A male and a female *S. fasciata* were isolated in a glass jar containing a little water. The female laid a batch of eggs on 3rd May, and these were isolated. On 6th May the first larvae hatched from these eggs; on 13th May the first pupae were seen; and on 14th May the first adults emerged. The adults were left together in the jar, and on 30th May the first batch of eggs was laid by them.

> Experiment XII. A male and a female *S. fasciata* were isolated in a glass jar as in Experiment I. The female laid a batch of eggs on 24th May, and these were isolated at once. On 27th May the first larvae hatched from these eggs; on 3rd June the first pupae were seen; and on 5th June the first adults emerged. The adults were removed, and a single male and female isolated. This female laid her first batch of eggs on 14th June. The eggs were isolated, and on 16th June the first larvae were seen to have hatched from them. These larvae eventually pupated and hatched out into adult mosquitos.

From these two experiments it is clear that adult *S. fasciata* mosquitos hatched from eggs laid by the same mother in the same batch are fertile with one another.

In the case of *S. fasciata* the fact that inbreeding does not destroy fertility can have but little importance, since the species is so exceedingly common in Accra that there can be no difficulty in the way of meetings between males and females

hatched from eggs laid by different parents. In the case of the rarer species, however, it has significance, since it must often be very difficult, one would think, for a male hatched in one place to find a female that was not the offspring of the same mother. This is especially true in mosquitos such as *Stegomyia* which, in captivity at any rate, pair very soon after emergence from the pupae. After hatching they generally rest for a time close to the place where they find themselves on emergence, and sometimes indeed they pair as soon as they rouse themselves from this rest.

The arrest of development observed in larvae bred in the laboratory.

The period of the life-cycle of *Stegomyia fasciata* varies considerably. The eggs under normal conditions generally hatch in three to four days, the larval stage usually lasts from seven to thirteen days, and the pupal stage one to five days. It is well known, however, that under certain conditions the duration of the cycle may be greatly extended. Francis, for instance, has shown that the eggs may remain viable for as long as six and a half months, at any rate if they are kept dry; and it must be the experience of everyone who has bred *S. fasciata* to any considerable extent that the eggs, even when left lying on the water, may remain dormant for a long time. Unlike the eggs of *Culex fatigans*, which generally hatch all at the same time, those of *S. fasciata* hatch one by one, or two or three at a time; and consequently most samples of larvae of this species sent for examination include individuals at various stages of development. No attempt has been made to determine the limits of the period of viability of eggs left lying in or on the water where they were laid, but I have notes of one experiment in which from eggs laid on 14th June perfectly healthy larvae (which eventually developed into adults) hatched on 20th July, the 37th day.

The larval stage also may be greatly prolonged. Even at the temperatures of the laboratory at Accra (average about 80° F.) it may sometimes extend far beyond the time accepted as the normal.

In the samples of mosquito larvae sent to the laboratory by the Medical Officer of Health an arrest of development is a common phenomenon. This is often troublesome, for it is easier, and more reliable, to identify adults than larvae, especially in the genus *Stegomyia*; and whilst waiting for the larvae to pupate and hatch, an unmanageable collection of bottles and jars is apt to accumulate. One larva of *Stegomyia luteocephala* was kept in this way for 53 days, as I was anxious to obtain another specimen of the adult mosquito, but eventually the hope was given up, and the larva was killed and preserved.

Of the larvae sent to the laboratory those of *Stegomyia* generally pupate and hatch quickly, those of *Culex* frequently die, and both alike are subject to the delayed development referred to above. The larvae thus arrested appear to be fully mature, but for some reason unwilling or unable to undergo the transformation into pupae. They have ceased to moult, and to the naked eye look perfectly healthy. It will perhaps be impossible to determine the maximum duration of the larval

period in these cases, but some larvae of *S. fasciata* are at present being kept to see how long it will be before they either die or pupate. At present their larval stage has lasted just over three months—that is, the larvae have been under observation in the laboratory for that time, but as they were already in the larval stage when they were received, it is impossible to say exactly how many days old they may be. Latterly, a good many of the larvae have died, but the last individual which pupated hatched into a healthy mosquito on the following day, exactly 100 days after the larva was received at the laboratory.

So far, the cause of this arrest of development has not been determined. It cannot, I think, be the bottles in which the larvae are kept, since other larvae in identical vessels develop normally. For the same reason, it cannot be either the temperature or the light. Neither does it appear to be due to an exhaustion of the food supply. It is possible, however, that it may be due to a fouling of the medium by the larvae themselves. Many of the larvae that die are found to be infected with ciliates, and to be covered with *Vorticella*, and it is possible that this may have some bearing on the phenomenon.

Experiments on the intolerance to common salt of the larvae of S. fasciata.

In 1914 some experiments were described on the action of common salt on the larvae of *Stegomyia fasciata*,* and it was pointed out that solutions of a strength of 2 per cent. were invariably fatal to them. Salt has, of course, been used as a larvicide for untold ages, indeed ever since some primitive man made the classical discovery of its preservative action which culminated in the introduction of salt beef and pork! The experiments referred to seemed to indicate nevertheless that salt might have a value in the campaign against *Stegomyia fasciata*, even if its application were restricted to the domestic utensils found littered about the native compounds and a flushing out of open drains with sea water.

The statements made in this paper referred of course to *Stegomyia fasciata* only; for many other species of mosquitos are known to breed in salt or brackish water. At Accra, for instance, *Ochlerotatus irritans* has been found breeding in water containing 1,400 parts of chlorine per 100,000, *C. fatigans* in water containing 1,600 parts, and *C. decens* in water containing 2,000 parts. The latter sample contained chlorine corresponding to 3·28 per cent. NaCl, a proportion considerably greater than that found in sea water.

C. fatigans was found breeding in water containing chlorine in proportions ranging from 2·6 to 1,600 parts per 100,000. *S. fasciata*, however, does not seem to possess this power of adaptability. Thirty samples taken at random of water in which larvae of this species were found breeding were analysed (see Table II.). The chlorine content ranged from 1·8 to 20·5 parts per 100,000, and averaged 4·3 parts; but as will be seen by reference to the Table, in 50 per cent. of the samples the chlorine was between 2 and 2·9 parts.

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* Bull. Ent. Res., iv, p. 339 (1914).

TABLE II.

The Salinity of Thirty Samples of Water in which the Larvae of Stegomyia fasciata *were found breeding.*

Chlorine in parts per 100,000.	Under 2	2–2·9.	3–3·9.	4–4·9.	5–5·9.	Over 5·9.
Number of samples examined which belonged to each group	1	15	3	6	2	3
Percentage	3·3	50·0	10·0	20·0	6·6	10·0

The highest proportion of chlorine (20·5 parts) found in water in which *S. fasciata* larvae were breeding was equal to only 0·032 per cent. NaCl. These observations suggest that *S. fasciata* selects water containing but a trifling proportion of salt for breeding purposes.

An attempt was made to determine by experiment whether or not *S. fasciata* did actually select her breeding place in this way. Cigarette tins were placed in pairs in various parts of the laboratory where it was thought mosquitos might be lurking, and in one of the tins 2 per cent. salt solution was placed, and in the other tap water. The result of the experiment was not conclusive, as larvae developed in only one of six tins set out. The one tin in which larvae did develop was, however, a tin containing tap water. The experiment was repeated with 2 per cent. salt solution and tap water to which a little broth had been added to make the media more nutritious; but the result was exactly the same, namely, larvae of *S. fasciata* developed in only one tin, a tin containing tap water.

In another experiment nine *S. fasciata* mosquitos (eight females and one male) that had already fed were introduced into a large glass jar at the bottom of which there was a layer of 2 per cent. salt solution in which a small beaker containing tap water was immersed. The mosquitos had therefore the choice of a large surface of saline solution, or a small surface of tap water, on which to lay their eggs. Two days later over a hundred eggs were found to have been laid on the tap water, but on the saline solution there were only four eggs, and these must have been killed almost as soon as they were deposited, for they had not hardened, but were still quite soft and white. In this single experiment the mosquitos certainly showed a preference for the tap water, and a corresponding reluctance to lay their eggs on the saline solution.

On several occasions larvae of *S. fasciata* were transferred from the water in which they were found breeding to another medium containing a high proportion of chlorine in which larvae of *C. decens* or *O. irritans* were flourishing. The *Stegomyia* larvae were always killed by the change, and the results were identical with those obtained in the experiments carried out at Lagos referred to in my former paper. In a medium containing 2,000 parts of chlorine (3·28 per cent. NaCl) in which

C. decens was breeding they were all killed within four hours, and in another medium containing 1,600 parts of chlorine (2·6 per cent. NaCl) in which *O. irritans* was breeding they were all killed within 16 to 20 hours.

In another experiment larvae of *C. fatigans* were transferred from the medium in which they had been breeding, which contained only 6 parts of chlorine, to a medium in which *O. irritans* was breeding which contained 1,600 parts. All the ten larvae transferred were dead within five hours. As on another occasion larvae of *C. fatigans* had been found breeding in water containing 1,600 parts of chlorine, this result seemed to lend support to the view that the action of the salt on the larvae was due to the hypertonicity of the solution. It also suggested that it might be possible to breed a race of *S. fasciata* that would tolerate a high percentage of salt.

Eggs of *S. fasciata*, recently deposited, were therefore introduced into (A) a medium containing 4·3 parts of chlorine in which *S. fasciata* larvae had been found breeding, and (B) a medium containing 1,400 parts of chlorine (equal to 2·3 per cent. NaCl) in which *O. irritans* had been found breeding. The details of the experiment were as follows:—

Experiment XIII.

Day of the experiment.	Medium containing 4·3 parts of chlorine.	Medium containing 1,400 parts of chlorine.
1	Ten eggs of *S. fasciata*, of a batch laid yesterday, introduced.	Twenty eggs of the same batch introduced.
3	First larvae (three) hatched.	No larvae have hatched.
7	Six larvae have hatched.	No larvae have hatched.
10	Four larvae and two pupae present.	No larvae have hatched.
11	First adult emerged.	As no larvae had hatched the eggs were transferred to a medium in which *S. fasciata* was breeding naturally.
15	Two adults have emerged; four larvae remain.	No larvae have hatched.
23	The last of the original six larvae emerged as an adult mosquito.	No larvae have hatched.
27	The first batch of eggs was laid.	No larvae have hatched.

Not only did the eggs fail to hatch out in the medium containing the high percentage of salt, but after being immersed in it for ten days they were apparently so much affected by it that they failed to hatch when transferred to a natural *S. fasciata* medium. The eggs in fact had been killed by the medium containing 2·3 per cent. NaCl.

Following the same line of thought, pupae of *S. fasciata* were placed in jars containing (A) 2 per cent. salt solution, and (B) tap water; and when the mosquitos hatched they were fed regularly with honey and blood, and a careful look-out kept for the appearance of eggs (see experiment XIV.).

Experiment XIV.

Day of the experiment.	2 % salt solution.	Tap water.
1	20 pupae of *S. fasciata* introduced.	20 pupae of *S. fasciata* introduced.
3	All the pupae have hatched.	Three pupae remain.
4		All the pupae have hatched.
5	8 a.m. The first mosquitos fed on blood.	8 a.m. The first mosquitos fed on blood.
9	No eggs yet.	The first batch of eggs laid.
15	No eggs, no larvae.	The first larvae hatched.
17	No eggs, no larvae.	More eggs laid.
19	No eggs and no larvae yet. Saline fluid poured off, and replaced by tap water.	More eggs; and many larvae.
20	Eggs laid on the surface of the water.	
21	More eggs laid.	First pupae seen.
23		First adults emerged.
24	First larvae hatched.	
30	First pupae seen.	
32	First adults emerged.	

On the tap water the first batch of eggs was laid on the ninth day, and further batches of eggs were deposited in rapid succession. On the salt solution, on the contrary, no eggs had been laid up to the nineteenth day, but on replacing the salt solution by tap water, eggs were deposited immediately which hatched into larvae in the usual time.

As this experiment was conducted with a relatively small number of mosquitos, a large number of pupae, namely a hundred, were placed in 2 per cent. salt solution in a large glass jar. All the pupae had hatched out by 8 a.m. on the third day, and on the fourth day the females began to feed on blood. Although the experiment was carried on for twenty-three days, no larvae appeared in the jar; but on the eighth day some white bodies were seen on the surface of the medium which resembled newly-laid eggs. These bodies did not turn black, but on microscopical examination it was evident that they were really eggs. They were quite soft, so that the pressure of a coverslip was sufficient to burst them. These eggs, as they were laid, must have been affected by the saline medium so profoundly and so rapidly that they neither hardened, nor turned black. Later, a very few black eggs were seen. As they were in the middle of clumps of the white eggs, it is probable that at first they may have been protected from contact with the saline fluid. They did not, however, hatch into larvae, so that presumably they were killed by it later.

These experiments seem to prove that the female *S. fasciata* either will not lay her eggs on 2 per cent. salt solution, even when no alternative breeding place is offered to her, or if her natural instinct compels her to do so, the eggs thus laid are rapidly killed by the solution, and no larvae result. Experiments have not yet been carried out with solutions of salt of a lower concentration than 2 per cent., but as the results with this percentage were so pronounced, it is not improbable that weaker solutions would have some similar deterrent effect.

In several of the experiments carried out with saline media it appeared that the development of the mosquitos was accelerated. Pupae of approximately the same age almost always hatched out into adults earlier in saline solutions than they did in the controls in tap water (see experiment XIV. above). The same phenomenon is illustrated in the following experiment :—

EXPERIMENT XV.

Date.	Tap water control.	Medium containing 0·49 % NaCl.
May 27th to June 6th, 1915	22 pupae of *S. fasciata* introduced.	22 pupae of *S. fasciata* introduced.
June 4th ..	First eggs laid this afternoon by the mosquitos that have emerged.	First eggs laid this morning by the mosquitos that have emerged.
June 7th ..	First larvae seen.	First larvae seen.
June 16th ..	No pupae yet.	First pupa seen.
June 18th ..	No pupae yet.	First adult emerged.
June 21st ..	First pupa seen.	
June 23rd ..	First adult emerged.	

This acceleration of the life-cycle in media containing an unusually high percentage of salt may be a natural reaction on the part of the larvae and pupae to protect themselves from the injurious effects of the drying up of the pools or small collections of water in which they would naturally have been breeding. As a pool of water dries up the concentration of its soluble saline constituents of course increases, and this may serve as a warning to the mosquitos breeding in it that they are in danger of being left high and dry.

NOTES ON AFRICAN CHALCIDOIDEA—III.

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It cannot be said that any satisfactory division of the Tetrastichini has yet been proposed. With the exception of one or two easily recognised groups like *Melittobia*, Westw., *Crataepus*, Först., and *Hyperteles*, Först., the genera are ill-defined, and this is specially the case with *Tetrastichus*, Hal., and its immediate allies. It has become evident that the mesonotal furrows or impressed lines have not the value for diagnosis that many writers have assigned to them. Recently Kurdjumov (Revue Russe d'Entomologie, xiii, p. 246, 1913) has separated *Tetrastichus* from *Geniocerus*, Ratz., by the chaetotaxy of the submarginal, assigning to the former genus those species which have one, and to the latter, species with more than one bristle in this position. Such a division, I believe to be unnatural, as it is certainly inconvenient.* In the following descriptions I have included one species in *Tetrastichus* though it has more than one bristle on the submarginal. I think it impossible, in the present state of our knowledge of the Tetrastichines, to say what characters are of basal importance. For grouping species, the funicle (shape, segments and chaetotaxy), the position of the scrobes, the shape of the pronotum (especially whether straight-edged or emarginate posteriorly), the chaetotaxy of the mesonotum and the propodeon, give generally the most reliable clues, while specific characters appear to lie in colour, proportions and chaetotaxy of the wings. How far the ring joint can or should be used is doubtful. When consisting of a number of equal rings it may be of some assistance, but in other cases, the basal ring is much the greatest, and it is almost impossible to say whether the succeeding lamina is distinct or not. Even with an oil immersion difficulty may be felt, and there is the further question of the morphological equivalence of these laminae. In the present paper four species assigned to *Tetrastichus* are described; of these, three are grouped together, mainly on account of antennal and propodeal characters, the fourth I have placed with some others described from dipterous hosts, but if the absence of whorls of hair from the male funicle proves to be more fundamental than the antennal coloration and the propodeal sculpture, possibly all four should go together. In describing the antennae, details are given of the sensoria, which, though rather variable in number on any individual joint, are more constant for the funicle and club as a whole.

The following features are shared by *Tetrastichus atriclavus*, *T. sculpturatus* and *T. mauripennis*, spp. nov.

♂♀. Wings more or less tinted; propodeon with median keel and pleurae ridged superiorly below the notopleural edge. The whole notum strongly raised reticulate or honeycombed; spiracle opening on the pleura outside the notopleural edge, surrounded by a hollow or sulcus which is distinct posteriorly.

♂. Scape with a large sense organ, fringed ventrally with long hairs. Funicular joint without any long basal or sub-basal whorls of hairs; antennae pale, except the dark club.

♀. Antennae dark, except scape.

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* *Cf.* Crawford, Proc. U.S. Nat. Mus., xlviii, p. 584, May 1915.

Tetrastichus atriclavus, sp. nov. (figs. 1, 2).

♂. Head, thorax and abdomen black, with dark shining, at most submetallic green or bluish green lustre on the notum of the thorax. Wings slightly tinged, nearly clear. Legs mainly yellowish, the femora a little browned and the coxae externally somewhat darker. The club of the antenna shows decidedly black against the yellow of the other joints; the scape is very pale while the pedicel and funicle have a slight tinge of brown.

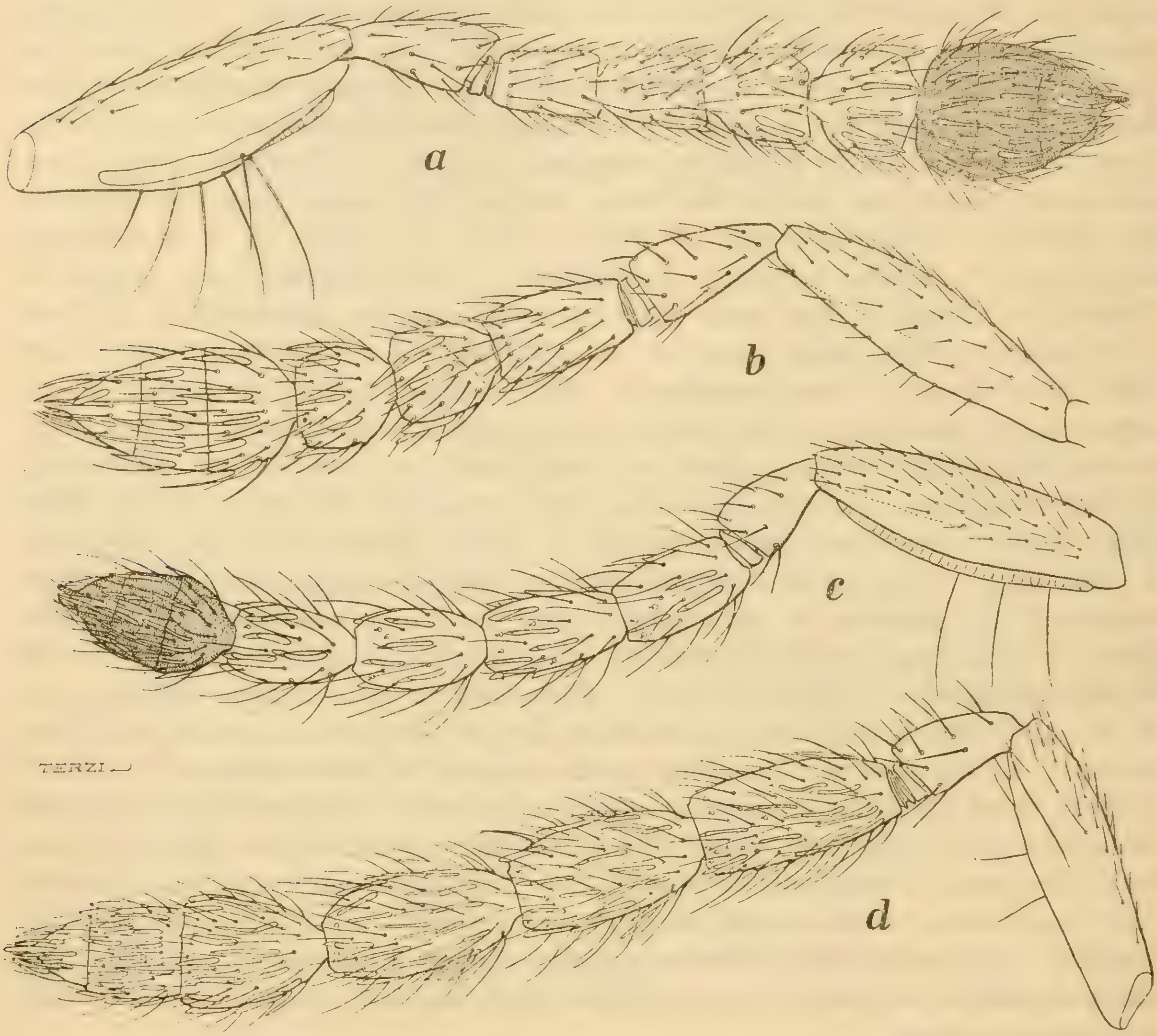

Fig. 1. *Tetrastichus atriclavus*, sp. n.; *a*, antenna of ♂ (outside); *b*, antenna of ♀ (inside).
T. mauripennis, sp. n.; *c*, antennae of ♂ (inside); *d*, antenna of ♀ (outside).

Head.—Eyes bare, separated by nearly twice the diameter of either, seen from in front; scrobes set on the base line of the eyes, with about ten bristles (5,5) between; frons between scrobes and anterior ocellus with many (about forty on each side) bristles in three rows, the post-scapal bare area thus narrow; about three bristles inside the genal ridge and two transverse rows (6, 4) below the scrobes, while three minute bristles stand on each median clypeal lobe; genae and occiput with many bristles. *Antennae* (fig. 1*a*) comprising scape, pedicel, ring joint, funicle of four joints, three in club. Length just under ·8 mm. Scape deep (20 : 7), internally

clothed with evenly set, short stiff bristles, externally with only a few such bristles. chiefly at the apex and along the dorsal edge ; 5–6 long curved bristles on outer ventral edge. Sense-organ broad and covering nearly all the ventral or subventral edge of the scape ; apically and basally it lies on the edge, while its median area lies above the edge. Pedicel two-fifths of scape, narrow (2 : 1) ; the ring joint is possibly double, as two thin laminae, of which only the first appears to be fused with the visible joint, intervene between it and the first of the funicle ; funicle gradually expanded, with equal joints, but as the last pair are sub-quadrate and pedunculate, they appear shorter than the first, which is much longer than broad (3 : 2) ; club joints in ratio 4 : 5 : 6 (reckoning the spur) ; whole club much swollen, about twice as broad as the first funicular joint. The first funicular with no sensoria externally, but one on the inside and another ventrally ; the second funicular bears four, one on dorsal, ventral. inner and outer aspects respectively ; the third has six (1, 2, 1, 2) ; the fourth eight (1, 3, 1, 3). In the segments of the club the arrangement is, (1st) 1, 6 (outside), 1, 4 ; (2nd) 1, 8, 1, 6 ; (3rd) 1, 3, 1, 2. *Mouth-parts* : labrum with four clear stout bristles (2, 2). Mandibles tridentate, the outermost tooth heaviest and most acute, separated deeply from the second, third tooth rounded and inconspicuous ; across the mandible runs a transverse row of four bristles ; maxillary palpus four times as long as the labial. with one long median outer bristle and a shorter subapical ; at the apex stands a third, long and stout, with a fourth very minute alongside. The lingua appears to have only four setigerous cells.

Thorax.—The pattern of the notum is, as a whole, fine and long drawn out. Mesonotum and scutellum with distinct impressed lines. Inside each parapsidal furrow are 4 stout bristles of which the first stands in front of the suture and the last beyond one-half ; the side lobes, with reticulations more nearly isodiametric, bear about 10 bristles ; axillae bare, with similar pattern to that of side lobes ; scutellum quadrate, with two well-defined furrows enclosing rather more than the median third, where the pattern is faint, while on the side areas it is more definite. The mid-area shows besides a very ill-defined central depression or weak impressed line. The post-scutellum (notum of the morphological metathorax) is honeycombed or deeply pitted and declivous about the middle line ; pleurae long and smooth. *Propodeon* with one median keel (a fusion of two) and two lateral, starting anteriorly just inside the large oval spiracles and converging posteriorly to enclose the peduncle ; at the anterior end of each lateral keel a ridge (at first thick, then thinning rapidly) rises on the pleura extending posteriorly and downwards, while below the spiracle is another much shorter pleural ridge. The spiracle thus lies in a rather deep narrow sulcus which extends to the suture with the metathorax. The notum of the propodeon is also sunk considerably on each side before the lateral keels. Between these hollows and the spiracle the surface is raised, crescentic, broadest behind. Except round the spiracle and about the middle of the central keel the notum and pleurae of the propodeon are coarsely raised reticulate. There are five or six bristles on the pleurae below the spiracle. On the mesosternum the prepectus is somewhat long and very coarsely raised reticulate ; on the sternum proper the reticulation is little raised ; the pleurae are rougher.

Wings (fig. 2).—Forewings not quite three times as long as broad (20 : 7) ; length, 1 mm. ; breadth, 0·35 mm. Submarginal : marginal : radius, as 4 : 4 : 1. The

submarginal bears a long bristle at one-third from the base; a little nearer the base, but below, is a clear non-setigerous pustule. Submarginal cell narrow, with about 10 bristles below; 10 to 12 stout bristles fringing the marginal appear over the costa. Radius with 4 bristles on stalk, one at the heel and one below the clear cells. There is a bare area below the origin of the marginal vein, and the basal triangle before the < row of hairs is also bare. Elsewhere the pubescence is regular and dense.

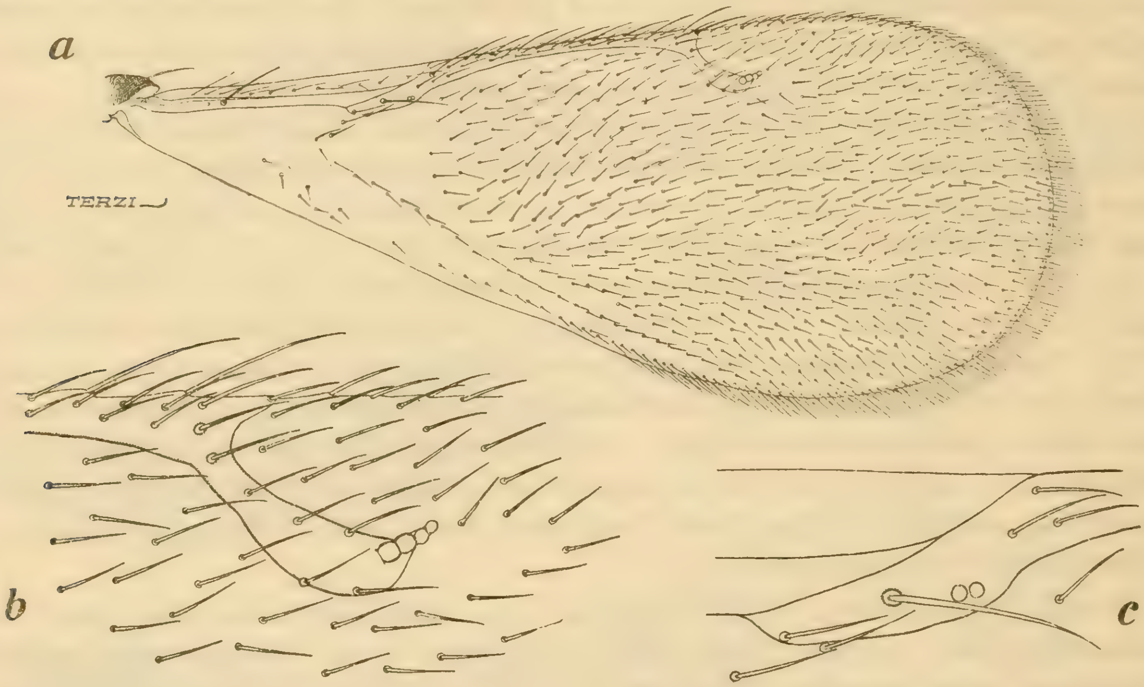

Fig. 2. *Tetrastichus atriclavus*, sp. n., ♀; *a*, right wing; *b*, radius; *c*, junction of marginal and submarginal.

Legs.—Forelegs: coxae two-thirds as long as the femora, which are only moderately swollen and have a ventral row of bristles (8–10); on the posterior aspect the femora are covered with evenly set bristles, but anteriorly the surface is bare ventrally to near the apex; apex of tibia with a row of 5 spines, and 6 along the anterior edge of first tarsal joint. Mid legs: femur bare both anteriorly and posteriorly on an area defined by a line from the upper basal to the lower apical angle, except for one or two posterior subventral bristles, one before and one after one-half respectively, and two rather strong subapical ventral bristles; numerous bristles along the dorsal edge on both sides broadening towards the apex; apical spine as long as the first tarsal joint. Hind legs: femur sparsely clothed; two bristles about the middle of the ventral edge, and 10 to 11 in a subventral row anteriorly; apical comb on tibia of 10 or 11 spines; tibial spur shorter than the first tarsal joint. The proportions of the tarsal joints are:—

	i.	ii.	iii.	iv.
Front	20	24	22	35
Mid	30	30	25	35
Hind	35	30	30	45

the fourth joint is reckoned to the bend of the claw.

Abdomen.—First tergite bare medianly, with three post-median bristles at each side; second tergite with bristles 5, 5; from the third to the fifth the arrangement is 8, 8, with about four on each side in front. On tergite vi. the spiracle is somewhat large, with one bristle inside and a post-median row of about 10. There are nine to ten bristles between the stylets. The retinacula of the penis are single and stout.

Length, $1\frac{1}{2}$ mm.; alar expanse, $2\frac{1}{2}$ mm.

♀. Similar to the ♂ in the colour of the body, wings and legs but the coxae are all clear yellow and the fore femora are never more than faintly darker near the apex. The general colour is a little duller than in the ♂. In the antennae the scape is pale, almost milky white, while the pedicel, funicle and club are black. The contrast between the sexes is here decided.

Head.—*Antennae* (fig. 1*b*): scape, pedicel, ring joint, funicle of three joints, and three in club; length just under 0·7 mm. Scape swollen medianly (19 : 5); hairs on inside sparsely set and on outside confined mainly to upper edge and towards the apex. Pedicel long and narrow (2 : 1), rather less than half of the scape (8 : 19). Ring joint as in the ♂. Funicular joints in the ratio 7 : 5 : 5 and expanded considerably on the third, so that the latter does not stand out so sharply as in the ♂. The club segmented in the ratio 11 : 10 : 14, and half as broad again as the first funicular joint; the sensoria are shorter, broader and fewer than in the ♂. *Mouth-parts*: the maxillary palpus bears medianly two bristles, an outer and an inner, not one as in the ♂.

In the *thorax* the ♀ differs slightly from the ♂ in that the scutellum is longer and not quite quadrate. On the *propodeon* the spiracle is large and the notum about the central keel more extensively smooth, while the reticulation is even coarser.

Wings.—Forewings a little shorter and broader than in the ♂. Length, ·95 mm.; breadth, ·37 mm.

Legs not so hirsute as in the ♂; the subventral rows of the femora have about three bristles less and the femora themselves are narrower. The proportions of the tarsal joints are the same in both sexes, except that while in the ♀ the second hind tarsal joint exceeds the first a little, the reverse is the case in the ♂.

Abdomen.—Ovipositor with only the apical one-twelfth to one-thirteenth of the sting serrate, but with many teeth (9–10) which are well developed. Free portion of sheath one-third of base. Sheath with one external bristle beyond one-half, and three to four stout, along the ventral edge, with in addition a patch (6) of much smaller bristles at the apex.

Length, slightly over $1\frac{1}{2}$ mm.; alar expanse, $2\frac{1}{2}$ mm.

SOUTHERN NIGERIA: Agege, 1913 (*Dr. W. A. Lamborn*).

Type—a ♂ in the British Museum; one of a series of 5 ♂♂ and 1 ♀, and 4 broken examples.

Tetrastichus mauripennis, sp. nov. (figs. 1, 3).

♀. Antennae blackish brown, the pedicel, the last funicular joint and the club almost black, the scape, especially on the ventral half, somewhat lighter. Head and thorax dull black. Wings brown-tinted, nearly as dark as scape. Legs, all coxae

and femora to near the apex blackish brown ; trochanters paler. Abdomen bluish black, shining but hardly metallic ; ovipositor light brown, the sheath black.

Head.—The eye is larger and more prominent than in *atriclavus*, and the head thus a little broader. In general the chaetotaxy is the same, the frons being very bristly. The infra-scapal bristles (10) are arranged differently ; in *mauripennis* they form a U-shaped row, dipping down to above the clypeus ; in *atriclavus* they are set in two horizontal rows (6, 4). *Antennae* (fig. 1*d*) : scape hardly swollen (7 : 2), with two long ventral bristles, one before and one after one-half ; pedicel (3 : 2), one-third of scape ; ring joint, one distinct joint succeeded by two laminae, much more clearly separated than in the ♀ of the preceding species ; joints one and two of funicle equal, and about one-twelfth longer than the third ; club segments in ratio 12 : 9 : 7. The club is hardly appreciably expanded, the whole antenna after the ring joint being cylindrical. Sensoria numerous ; on joints of funicle : (1st) 1 (upper edge), 10 (outside), 1, 10 ; (2nd) like 1st ; (3rd) 2, 12, 2, 12 ; on club : (1st) 2, 9, 2, 9 ; (2nd) like 1st ; (3rd) 2, 3, 2, 3. Length of antenna, 1·3 mm. *Mouth-parts* : mandibles of the same type as *atriclavus*, but they might be better described as bidentate, the upper inner edge being rounded off after the second tooth. Maxillary palpus a little over two and a half times as long as the labial.

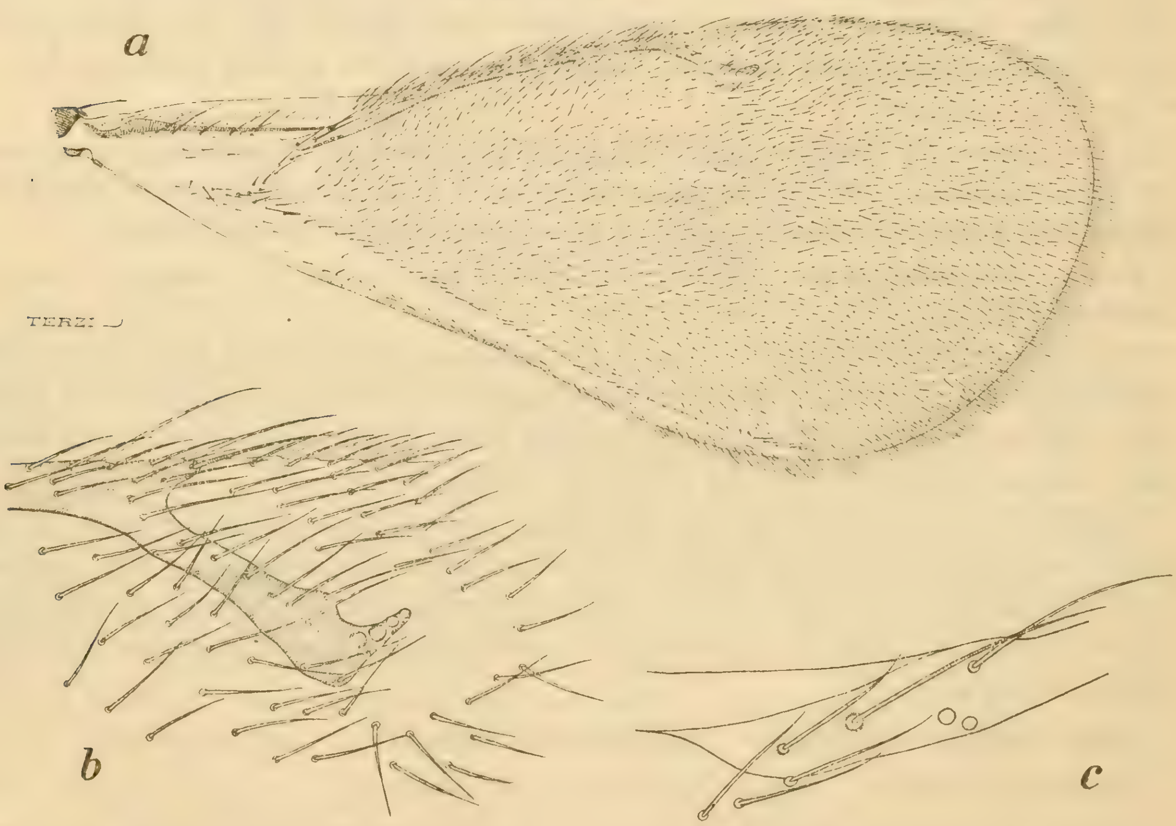

Fig. 3. *Tetrastichus mauripennis*, sp. n., ♀ ; *a*, right wing ; *b*, radius ; *c*, junction of marginal and submarginal.

Thorax.—Pronotum with moderate regular raised reticulation, the mid region weakly chitinized ; on each side of the mid line are over 30 minute bristles, becoming stronger posteriorly, while there is a posterior row of 20 bristles ; episternite and sternum with coarse raised pattern. Mesonotum with a deep central furrow ; inside

each parapsidal furrow a row (8–9) of bristles extending from the scutellar suture to three-fourths. Side lobes with 10 to 11 minute bristles. The pattern of the mid lobe so drawn out and fine that the surface shows many irregular closely set striae, on the scutellum the pattern is again regular, the cells being raised, so that the surface of the middle area especially is finely mammillated. Post-scutellum pitted and rounded in some specimens, but in most the propodeal keel is carried forward. Structure of the propodeon as in *atriclavus*, but the whole notum is honeycombed deeply and coarsely ; 7 to 8 cells on each side of median keel ; five bristles below the spiracle ; pleurae below the spiracle smoother.

Wings (fig. 3).—Fore wings rather over twice as long as broad ; length, 2·25 mm. ; breadth, 1 mm. Submarginal : marginal : radius, as 10 : 15 : 4. Submarginal with 5 bristles ; submarginal cell with about 14 bristles ; marginal with 20 stout bristles, appearing beyond the costa. The radius bears about 12 bristles disposed as in the figure. There are 4–5 bristles below the submarginal vein on the basal triangle. Hind wings barely $3\frac{1}{2}$ times as long as broad. Submarginal : marginal, as 5 : 7. Whole surface densely hairy, except on the small triangle subtended by the submarginal, where there are only one or two minute scattered bristles ; the comb of short bristles at the end of the marginal below the hooks of the frenulum numbers 9–10. Length, 1·7 mm. ; breadth, 0·5 mm.

Legs.—Fore legs : coxae with three subapical external stiff bristles, and as many more (shorter) on the outer surface ; femur nearly bare anteriorly, but below the dorsal edge there are 8–10 short bristles in a row ; a similar ventral row of stiff, rather long bristles ; on the posterior aspect are about 20 stout bristles widely but evenly spaced ; tibiae bare posteriorly, with sparsely set bristles anteriorly ; apical comb of 6 spines ; comb on first tarsal joint with 9–10 spines. Mid legs : femora very bare, there being only a scattered row (4 or 5) of bristles about the middle of both aspects and a few shorter on dorsal edge and near the apex, besides the usual apical bristles ; no ventral row ; hind femora with only one or two long bristles more than the mid pair ; the tibial comb with only 6 to 7 spines. The proportions of the tarsal joints are :—

	i.	ii.	iii.	iv.
Fore	30	35	35	65
Mid	45	45	35	75
Hind	60	55	45	75

Abdomen.—The integument, which has lost practically all its pattern, is smooth and shining, but highly magnified it shows numerous minute raised points. The tergites are extremely pilose, 80 to 90 bristles, occurring on the sixth alone. Anteriorly the bristles or hairs are sparser, but even tergite i. bears about 20. Between the stylets are about 30 straight stiff bristles, with many more outside. The ovipositor is similar in proportions and shape to that of the preceding species ; the free portion of the sheath is narrower, with the superficial bristles nearer the apex ; it is rather over one-third of the base.

Length, $2\frac{3}{4}$ mm. ; alar expanse, 5–$5\frac{1}{2}$ mm.

♂. Antennae yellowish brown, the club very black. The thorax not so dull as in the ♀. Wings more faintly brown-tinted than in the ♀. Legs yellowish brown, the mid femora with a darker streak superiorly; the coxae blackish near the base, otherwise clear brown; hind coxae distinctly blue-black and shining above. Abdomen as in ♂, except the median basal one-third, which is transparent yellow.

Head.—Antennae (fig. 1*c*) with the sense-organ on the scape slightly longer than in *atriclavus*, with only three long bristles standing on the outer aspect, and subventral rather than ventral. Pedicel shorter and broader than in *atriclavus* (4 : 3), and two-sevenths of the scape in length; in *mauripennis* the pedicel is shorter than the first funicular joint (8 : 11), in *atriclavus* it considerably exceeds the first funicular joint (7 : 5). The funicular joints are sub-equal, the second being very slightly longest and the fourth the shortest; the first pair are cylindrical and the others, having the angles rounded, appear to be shorter than they really are. The club is not quite three-fourths as long as the last pair of funicular joints together, while in *atriclavus* the sum of those joints is not quite as long as the club; in *mauripennis* the club, segmented in ratio 8 : 7 : 6, is hardly swollen and not more than one-sixth wider than the first joint of the funicle. Sensoria as follows: first funicular, 1, 3, 1, 3; second to fourth 2, 4, 2, 4; on club: (1st) 1, 5, 1, 4; (2nd) 1, 4, 1, 4; (3rd) 1, 1, 1, 1. Length of antenna, 1·1 mm.

Length of ♂, over 2 mm.; alar expanse, 3·8 mm.

Nyasaland: Mt. Mlanje, 6.i.1914 (*S. A. Neave*).

Type, a ♀ in the British Museum, one of a series of 1 ♂ and 44 ♀♀.

Tetrastichus sculpturatus, sp. nov. (figs. 4, 5).

♀. Antennae with the funicle and club black, scape pale, pedicel darker, but not so black as the funicle. Head and abdomen purplish black, with indefinite reflections. Thorax with the pleurae dull black, notum with a slight dark blue or green tinge. Wings distinctly tinted, darker a little below the marginal. Legs with the coxae nearly black, fore femora darker brown, all tibiae, tarsi and trochanters pale; mid and hind femora a little darker.

Head broad across the frons; eyes separated by more than two diameters; otherwise as in the preceding species. *Antennae* (fig. 4*b*), length 1 mm.; the scape narrow (9 : 3), with six to seven weak short bristles along the ventral edge, the two subapical being a little stronger; pedicel narrow (7 : 3) and more than one-third of the scape (7 : 18); funicle gradually expanded, the last joint wider (9 : 7) and very slightly shorter than the first, while i. and ii. are equal; club segmented in the ratio 9 :6 : 7, but not much wider than the last funicular joint. Sensoria on funicle: (1st) 2, 2, 2, 2; (2nd) 2, 4, 2, 4; (3rd) 2, 4, 2, 5; on club: (1st) 2, 9, 2, 9; (2nd) 2, 6, 2, 6; (3rd) 1, 3, 1, 3. *Mouth-parts:* maxillary palpus thrice the labial, with one outer median bristle.

Thorax.—Pronotum with posterior row of ten bristles, the edge distinctly excavated at the spiracle. Mid lobe of mesonontum with three stout bristles inside the parapsidal furrows, all on the mid region and none near the scutellum. Propodeon similar to that of *atriclavus*, the notum being coarsely reticulate anteriorly with a smoothed median area round the central keel and sunk before the lateral keel, but

not irregularly deeply honeycombed as in *mauripennis*; all round the spiracle, between the pleural and the upper keels, the surface is roughened and raised. The fused keels composing the central keel, which is continued through the metanotum, are more plainly distinguishable in this species than in either of the others.

Wings.—Fore wings (fig. 5) over $2\frac{1}{2}$ times as long as broad; length, nearly 1·6 mm., and breadth, 0·6 mm. Submarginal : marginal : radius, as 7 : 8 : 2. One bristle on the submarginal; 10 or 11 on the narrow cell below; 9 to 10 stout bristles appearing

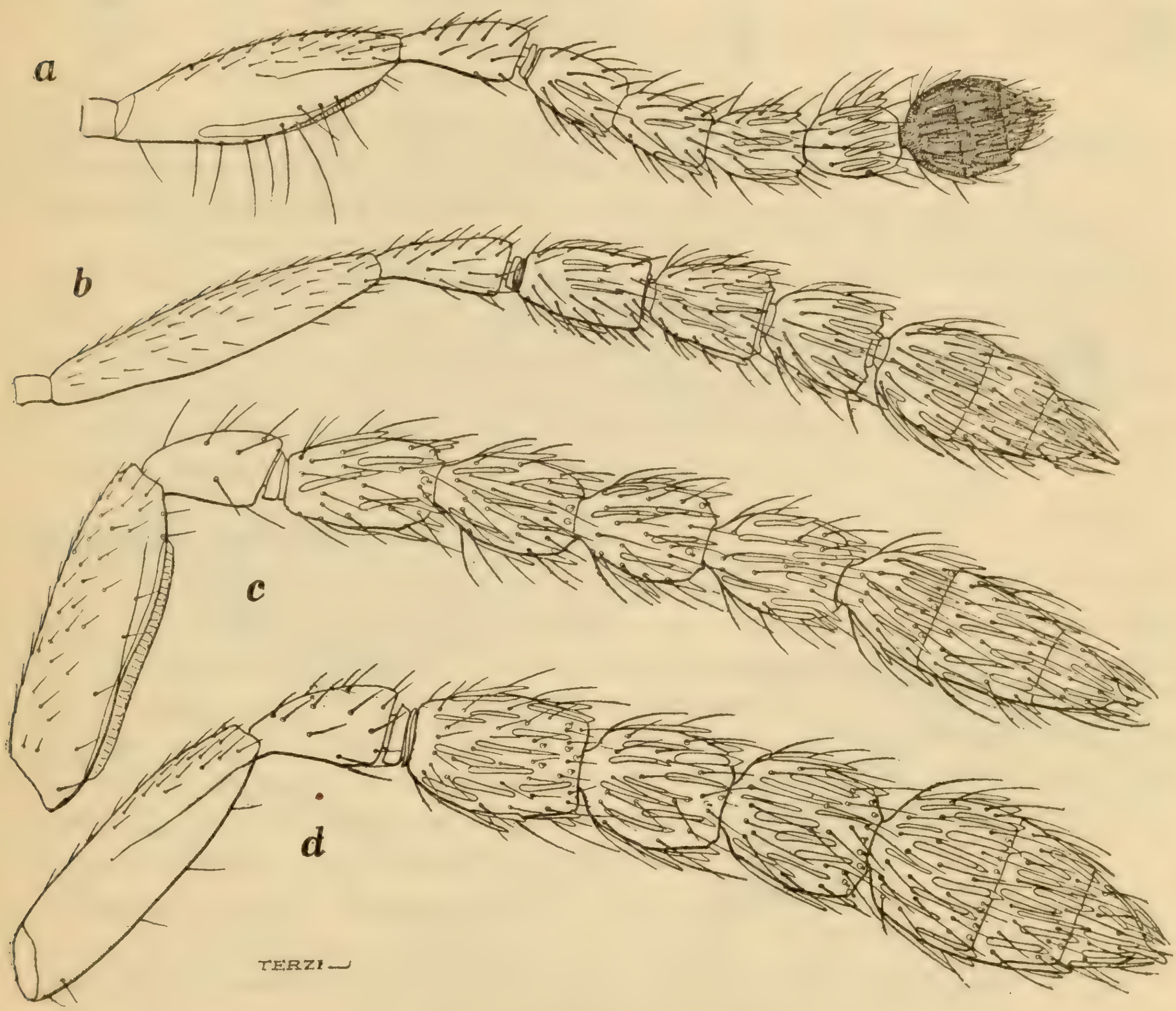

Fig. 4. *Tetrastichus sculpturatus*, sp. n.; *a*, antenna of ♂ (outside); *b*, antenna of ♀ (inside).
T. balteatus, sp. n.; *c*, antenna of ♂ (outside); *d*, antenna of ♀ (outside).

over the edge below the marginal vein; 8 to 9 bristles on the radius above. Alar pubescence dense, coming close up to the veins and extending nearly to the origin of the marginal. Hind wings $3\frac{1}{2}$ times as long as broad; length, 1·3 mm.; breadth, 0·4 mm. Submarginal five-sixths of the marginal.

Legs.—Fore legs: the anterior surface of the femora bears more bristles, only the ventral two-fifths being bare; the row of bristles at that level numbers 13–14; the apical tibial comb is peculiar, consisting of three pustulated spines with a bristle at

either side; comb of the first tarsal joint of 9–10. Mid legs: coxae bare, except for two stout bristles, one above the trochanter and one apical; tibial spur short, not three-fourths of first tarsal joint. Hind legs with tibial comb of 9 or 10 spines. The proportions of the tarsal joints are:—

	i.	ii.	iii.	iv.
Front	30	35	30	50
Mid	50	45	35	55
Hind	55	50	35	60

Abdomen.—Surface not densely clad; the bristles short; first and second tergites with 6 each; third and fourth tergites, 7 to 9 on each side, with one or two in front; on the fifth tergite, one or two more bristles in each row; the sixth and seventh

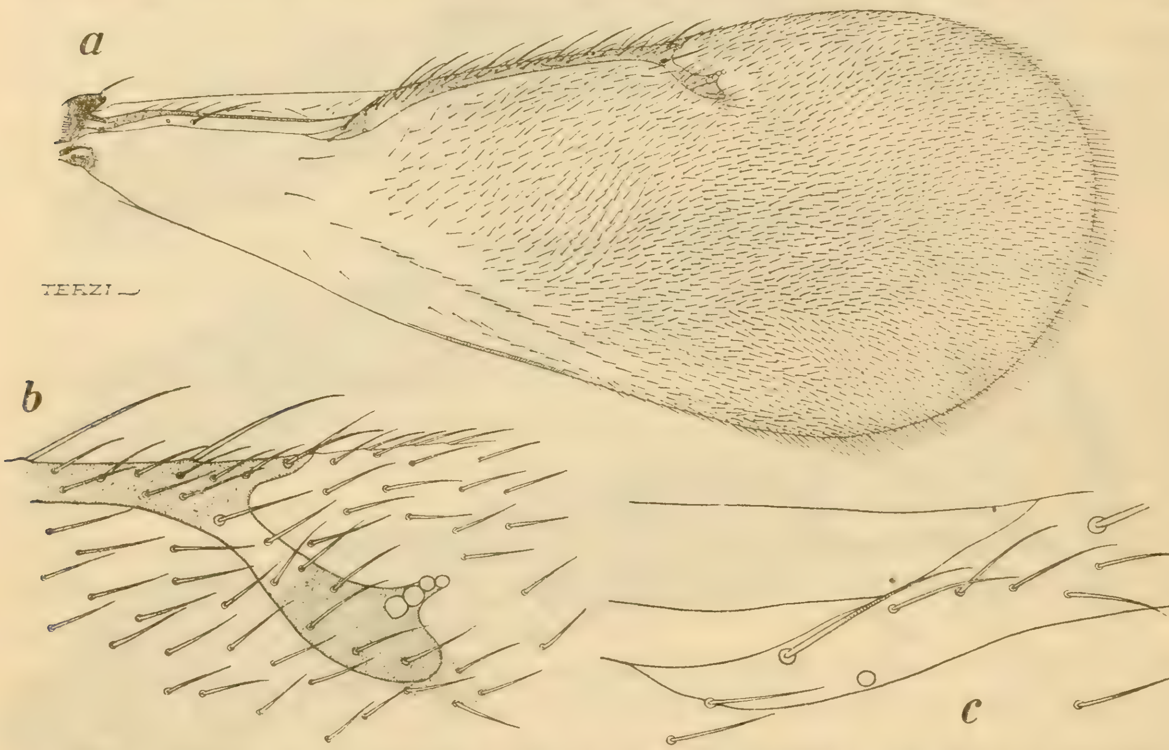

Fig. 5. *Tetrastichus sculpturatus*, sp. n., ♀; *a*, right wing; *b*, radius; *c*, junction of marginal and submarginal.

have a posterior row of about 14 bristles, with at each side, 6 or 7; 16 bristles between the stylets; the free sheath is one-third of the base.

Length, 2 mm.; alar expanse, 3·75 mm.

♂. Antennae pale to the end of the funicle, with sense organ on the scape narrowly darker; club darker. Head, body and wings as in the ♀, the wings of nearly the same tint in both sexes. Legs with coxae black, the remainder yellowish, the femora at most with darker upper and lower edges; the fore femora hardly darker than the others.

Head.—*Antenna* (fig. 4*a*). Length, 0·9 mm.; scape much swollen, about half as broad as long, with one or two more bristles on the apical external surface than in the

two preceding species. Sense-organ extending from near the apex to within one-fourth from the base and lying mainly along the ventral edge, with a fringe of 9 bristles. Pedicel two-fifths of the scape; longer than the first funicular joint; the club segmented as in *mauripennis*, shorter than the two preceding joints together, but wider than the first funicular joint (7 : 4). Sensoria on funicle: (1st) 1, 0, 1, 1; (2nd) 1, 1, 1, 1; (3rd) 1, 2, 1, 2; (4th) 1, 3, 1, 3; on club: (1st) 1, 4, 1, 5; (2nd) 1, 4, 1, 6; (3rd) 1, 3, 1, 2. In the antennal characters therefore, *sculpturatus* is intermediate between *atriclavus* and *mauripennis*.

Length, 1·5 mm.; alar expanse, 3 mm.

UGANDA: South of Lake George, bred from larvae of a butterfly, *Neptis agatha*, Cram., 6.vi.1911 (*C. C. Gowdey*).

Type, a ♀ in the British Museum, one of a series of 2 ♂♂ and 55 ♀♀.

The species described below, belongs to a group which shows more or less completely the following characters:—

♂♀. Antennae concolorous, at most the scape lighter. Propodeon simple, the surface smooth and raised reticulate, but not pitted; one keel or raised edge between notum and pleura, with the spiracle lying outside without surrounding hollow. Scutellar furrows deep. Legs robust, generally dark to near apex of femora and lighter afterwards. Wings with one hair on the submarginal, and a non-setigerous pustule a little nearer the wing base. Steel blue or black species; many described from dipterous hosts.

Tetrastichus balteatus, sp. nov. (figs. 4, 6).

♀. Scape and pedicel of antenna pale, the latter a little darkened or smoky; funicle and club blackish brown. Head very dark, shining green, submetallic, becoming blacker near the clypeus, with a tinge of blue on the frontal side of the genal ridge. Mesonotum before the suture like the head; on the scutellum the dark blue tint is more apparent; pleurae blackish brown. Wings hyaline, veins light brown. Coxae black, with blue reflections on outer aspect of first pair; femora black to before the apex, thence to the claws the entire legs are yellow; claws black. Propodeon duller, abdomen more shining, like the head

Head a little wider than deep (6 : 5), with the eyes rather prominent and separated by nearly 3½ diameters. The bare post-scapal area is broad, but there are the usual small bristles about the sides of the frons. Scrobes clear of the base line of the eyes, with only 1–2 minute bristles between. Below each scrobe are two similar bristles, but only one or two occur lower above the clypeus. *Antennae* (fig. 4 *d*): length, 0·8 mm.; scape with subparallel sides (4 : 1); four widely spaced ventral bristles; outside bare, except narrowly towards the apex; one stout ring joint and two thin laminae; funicular joints, 6 : 5 : 5; club, 10 : 9 : 6. The funicle is cylindrical and the club slightly expanded, its breadth compared with that of the first funicular being as 5 : 4. Sensoria numerous; on funicle: (1st) 2, 10, 2, 10; (2nd) 2, 6, 2, 8; (3rd) like 2nd; on club (1st) 2, 10, 2, 10; (2nd) 1, 8, 1, 8; (3rd) 1, 3, 1, 3. *Mouth-parts.* Mandibles with the lowermost tooth strong and deeply separated from the inner pair, which are rounded; the upper edge is narrowly incised in the middle. Labial palpus one-quarter of the maxillary.

Thorax.—Pronotum with the spiracular incision distinct, though not deep; surface rather coarsely reticulate and raised, posterior row of fourteen bristles, none standing in front of the spiracular incision. Mesonotum with two rows of bristles inside the parapsidal furrows; the outermost with six to seven; the inner one complete near the suture, with one or two fewer bristles; median sulcus distinct; on the scutellum the two sulci are very deep and the first bristle occurs behind one-half; all the pattern, both on mid lobe and scutellum, striate reticulate; all the sterno-pleural surfaces rough, the prepectus and episternite coarsely so. Post-scutellum rough, carinate. Propodeon with the spiracle outside the lateral ridge, notum and pleurae nowhere smooth, raised reticulate or roughened, six to eight hairs below the spiracle, which distinctly opens on the pleurae.

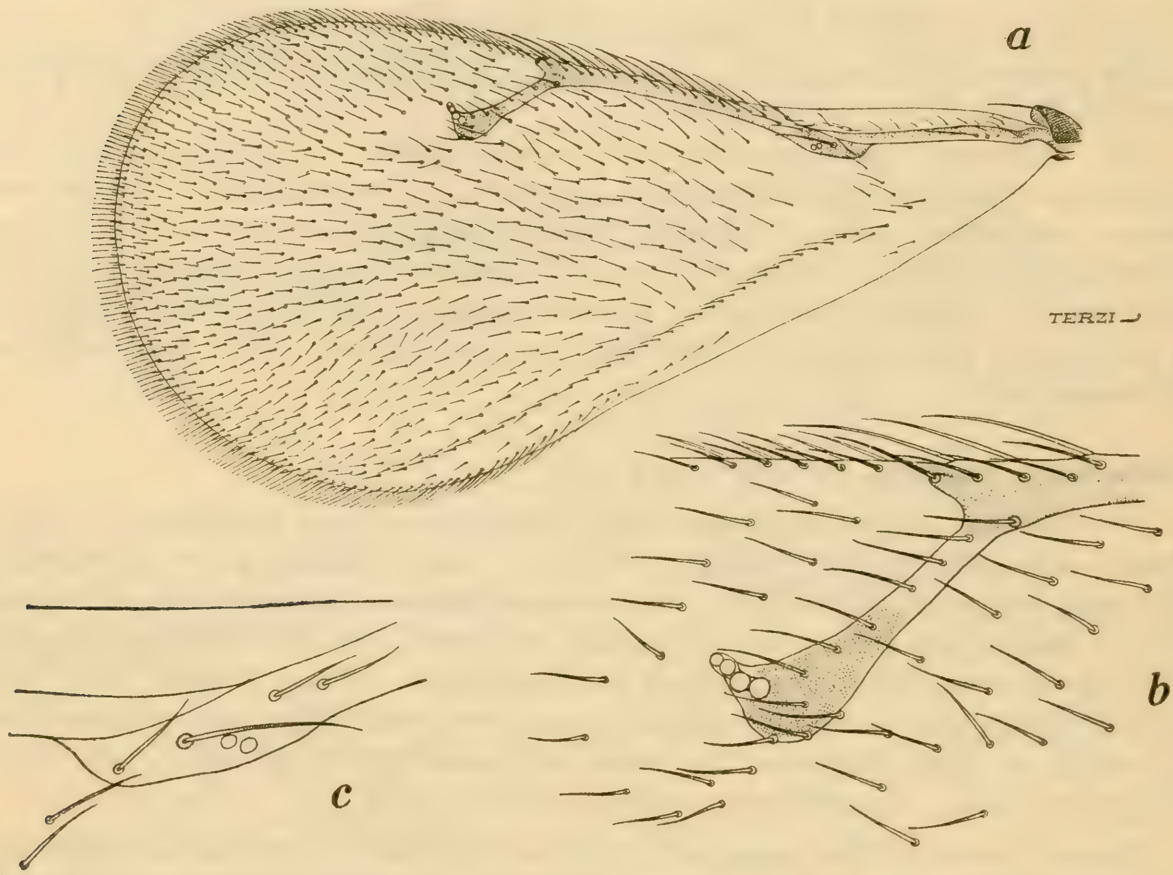

Fig. 6. *Tetrastichus balteatus*, sp. n., ♀; *a*, left wing; *b*, radius; *c*, junction of marginal and submarginal.

Wings (fig. 6) twice as long as broad; length, 1·4 mm.; breadth, 0·7 mm. Submarginal : marginal : radius, as 8 : 8 : 3. One bristle on submarginal, 15 on marginal, about 12 on radius, and bare on a spot on the other side of the < line of hairs. Beneath the marginal the hairs stand a little back and are more sparse, while on the broad apex they are denser; the posterior bare margin is rather broad. Hind wings four times as long as broad; length, 1·2 mm.; breadth, 0·3 mm.; submarginal : marginal, as 7 : 6.

Legs.—Fore legs: coxae rough outside, with minute bristles near the base, and about 12 scattered on the surface—3 near the apex larger; smoother on the inside, with 5 to 6 fringing bristles at the apical edge and 2 or 3 in a vertical row above;

on the anterior aspect of the femur, the median row of bristles has a broad, bare space above, while the ventral bristles are stout ; apical tibial comb of 6 spines, comb of first tarsal joint of 9. Mid legs : coxae with 4 stiff bristles in a row parallel to exterior apical edge ; internally bare, whole surface rough. Hind legs : coxae with coarse reticulations ; about 12 minute bristles on the basal two-thirds of the exterior aspect, and 6 to 8 larger towards the apex ; interiorly 4 bristles near the apex. Tibial comb of 9 to 10 spines. The proportions of the tarsal joints are :—

	i.	ii.	iii.	iv.
Fore	25	30	25	40
Mid	35	40	27	40
Hind	40	40	35	55

Abdomen.—On all the tergites the surface is smooth, broadly along the mid line, but the reticulations appear on the sides and overlapping flaps. From the third segment onwards the tergites are, especially laterally, very bristly ; from the third tergite onwards the posterior row of bristles is uninterrupted ; on tergite iii. this row contains 16–17 bristles and as many more in a patch on each side ; on tergite iv. the row numbers about 20 bristles and the patches are correspondingly increased ; the bristles increase in number on the fifth tergite and are reduced again on the sixth, where the posterior row contains 20. The spiracle is minute. The mid lobe of the fifth sternite is narrow and produced, and there are exceptionally one or two minute bristles on each side of the central pair. There are only 12–13 bristles between the stylets.

Length, 2 mm. ; alar expanse, nearly 3·25 mm.

♂. More intensely black than the ♀, with the metallic reflections more pronounced. Antennae wholly black. Legs with femoral tips more narrowly pale.

Head.—*Antennae* (fig. 4 *c*) : scape (3 : 1) with large sense-organ lying wholly on and occupying two-thirds of the ventral edge, and equidistant terminally from base and apex ; internal surface bare, except for two rather strong bristles subventral and basal in position ; externally above the hollow into which the pedicel folds are numerous scattered short bristles ; two subapical ventral bristles between the sense-organ and the pedicel, placed in a subventral line above the organ, and hardly extending beyond the ventral edge. Pedicel shorter than the first funicular joint ; funicle and club cylindrical, the latter elongated, and about one-sixth broader than the first funicular joint. The joints of the funicle (7 : 5) are equal in pairs, the first and second being a trifle longer than the third and fourth. The bristles of the funicle are irregularly placed and nowhere form definite rows with contiguous pustules ; all are of the same calibre and the largest not more than four-fifths of the joint on which they stand. Club $2\frac{1}{2}$ times as long as the preceding joints and segmented in the ratio 6 : 8 : 5. Sensoria on funicle : (1st) 2, 4, 2, 3 ; (2nd) and (3rd) 2, 6, 2, 5 ; (4th) 2, 5, 2, 8 ; on club : (1st) 1, 4, 1, 5 ; (2nd) 1, 6, 1, 5 ; (3rd) 1, 2, 1, 2. Length of antenna, 0·8 mm.

Length, 1·5 mm. ; alar expanse, 3 mm.

NYASALAND : Port Herald, bred from pupa of a Lymantriid moth (*Dr. J. E. S. Old*).

Type, a ♀ in the British Museum, one of a series of 1 ♂, 20 ♀♀.

Several species closely related to *T. balteatus* have recently been described by Prof. Silvestri, viz. : *giffardi* (1913), *oxyurus* (1913), *giffardianus* (1915) and *dacicida* (1915). Silvestri's species are all parasitic on fruit-flies (*Dacus*, etc.). From *giffardi*, *giffardianus*, and *dacicida*, *balteatus* ♂ differs in the chaetotaxy of the funicle, in the relative length of the first funicular joint, in the size of the scapal sense-organ and its fringing bristles. With *giffardi* I have been able to make direct comparison (a series from Aburi; identification confirmed by Prof. Silvestri) and there appear to be numerous minor differences between the species. The ♀ of *balteatus* may likewise be known by the first funicular, the radius, etc. Of the African *Tetrastichus*, *balteatus* probably stands nearest to *dacicida*, but the proportions of the hind tarsal joints appear to be different. In going over the collection in the British Museum an even closer ally was found in *Tetrastichus tachos*, Wlk. (Ann. Mag. Nat. Hist. ii, p. 352, 1839), from England.

A note on the antennal characters of *T. tachos* may be given.

Tetrastichus tachos, Walk. ♂.—*Antennae* (fig. 7 *a*) : length over 1 mm. ; scape with sense-organ covering four-fifths of the ventral edge ; eight bristles fringing the sense-organ ; outside bare, inside with sparse, evenly set bristles which tend to form a regular subventral row, especially near the apex. Each funicular joint bears near the base a whorl of tubular bristles (8–9) on the outer and dorsal aspects ; the first pair of joints equal and slightly shorter than the second pair, which are also equal. The sensoria are fewer in number and shorter, and with longer flanges than in *balteatus*. *Wings*. There are more bristles on the radius than in *balteatus* (figs. 7 *b*, 8 *b*).

Syntomosphyrum phaeosoma, Wtrst. (figs. 7, 8).

Since describing this species (Bull. Ent. Res., v, p. 370, 1915) I have seen 1 ♂ and 5 ♀♀ bred from the cotton leaf-roller (*Sylepta derogata*), at Dedza, Nyasaland, by Mr. E. Ballard. In these examples the first two joints of the funicle are a little lighter than in the type (bred from the same host, in N. Nigeria), but the agreement is otherwise complete. I take this opportunity of describing the species in more detail and of noting the differences between it and *S. glossinae*, Wtrst. Both species have the mesonotum densely pilose on the mid lobe, while the first of the scutellar bristles occurs *before* one-half from the suture. There is a short, stout bristle immediately above the spiracular emargination on the pronotum, and the submarginal bears three bristles. The propodeal spiracle lies *inside* the notopleural ridge.

♀. Antennae pale, clear yellowish brown from scape to nearly end of funicle ; last funicular joint obscured and club darker.* Head and thorax non-metallic purplish black, a little shining ; eyes reddish chocolate. Wings clear, veins very light brown. Fore coxae entirely, and mid coxae (above), concolorous with thorax ; hind coxae transparent, light brown ; legs elsewhere yellowish brown—at most the fore femora with a smoky streak. Abdomen with the peduncle narrowly

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* In the type the 1st and 2nd joints are also smoky.

transparent brown, like the hind coxae, so that under a low power there is a clear space behind the propodeon, otherwise coloured like head and thorax; the tergites (especially the first) show in some lights slight greenish or bluish reflections; ovipositor pale yellow, contrasting with the body colour; sheath like the rest of the abdomen.

Head wider than deep (6 : 5); eyes separated by about $3\frac{1}{2}$ times their own diameter, and with scattered short pubescence. *Antennae*: length 0·5 mm.;

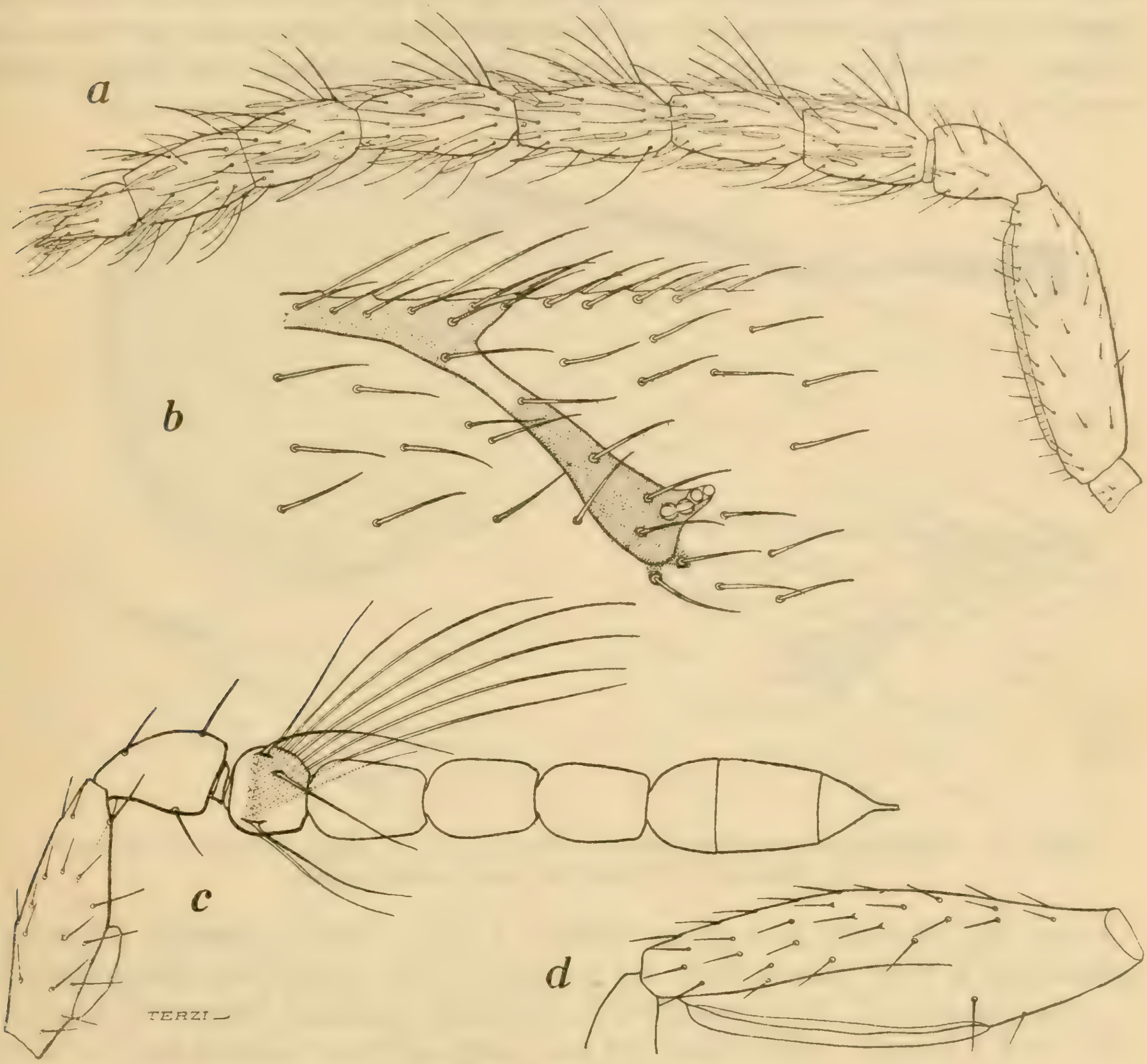

Fig. 7. *Tetrastichus tachos*, Walk.; *a*, antenna of ♂ (inside); *b*, radius. *Syntomosphyrum phaeosoma*, Wtrst.; *c*, antenna of ♂ (inside), chaetotaxy shown only as far as 1st funicular joint. *S. glossinae*, Wtrst.; *d*, scape of antenna of ♂ (inside).

scape hardly expanded medianly, $3\frac{1}{2}$ times as long as broad; with 6–7 ventral bristles and few others on either surface. Pedicel (3 : 2) half as long as scape; ring joint half as long as the first funicular; funicular joints quadrate, equal; club segmented in the ratio 7 : 5 : 5, and $2\frac{1}{2}$ times as long as a funicular joint, and half as broad again. Sensoria on funicular joints: from 5 on first to 7 or 8 on third; on club: (1st) 1, 4, 4, 1; (2nd) 1, 3, 3, 1; (3rd) 1, 1, 1, 1. *Mouth-parts*: mandibles short, with the second tooth sloping away from the first.

Thorax. Pronotum with a stout bristle above the spiracle, and a posterior row of 8 to 9; surface with moderately coarse reticulations and numerous (about 100) short bristles. Prosternite with coarse raised pattern. The mesonotum is similar to that of *S. glossinae*, there being 60–70 short bristles on the mid lobe, 2 at the postero-lateral corners stronger, and over 12 on the side lobes; the anterior bristle lies well before one-half and the non-setigerous pustule is a little inwardly displaced. The prepectus is coarsely reticulate; the episternite lower down is extensively rough, while the epimeron again is smoother. Reticulation of sternum most definite posteriorly. Metanotum shining, not so roughened on notum and pleurae as in *glossinae*. Propodeon entirely roughened (raised reticulate); the lateral keels posteriorly convergent and the spiracle lying just inside the anterior angle.

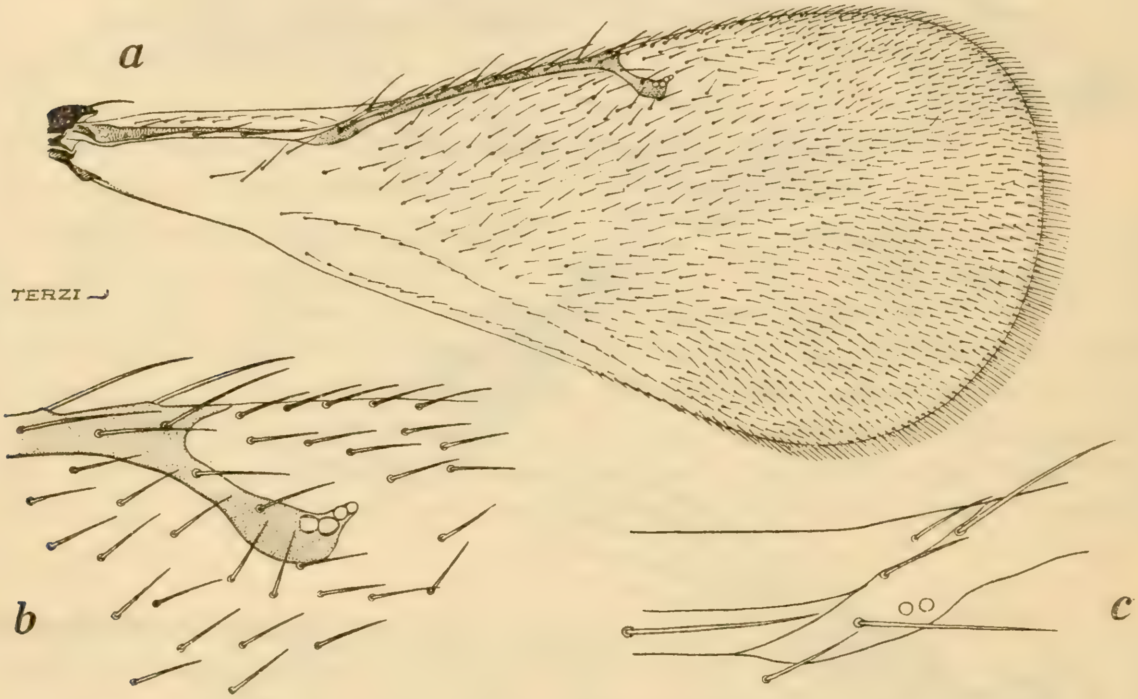

Fig. 8. *Syntomosphyrum phaeosoma*, Wtrst., ♀; *a*, right wing; *b*, radius; *c*, junction of marginal and submarginal.

Wings (fig. 8) twice as long as broad; length, 1 mm.; breadth, 0·5 mm.; submarginal a little shorter than the marginal; but roughly the proportions of the veins are 4 : 4 : 1. Submarginal with 3 bristles; marginal fringe of 10 bristles; radius with 3 bristles. Hind wings, 0·9 mm. long, and four times as long as broad.

Legs. The coxae, especially of the hind legs are coarsely raised reticulate above. The first tibial comb consists of five spines and there are as many along the anterior edge of the first fore tarsal joint. In the forelegs the proportions of the tarsal joints are exactly as in *glossinae*, but the species differ in the posterior pairs.

	i.	ii.	iii.	iv.
Mid leg	35	30	25	35

The hind tarsus has the second joint a little longer.

♂. Similar in colour to the ♀. The antennae (fig. 7 *c*) are concolorous, pale, but a little and evenly smoky ; length, ·44 mm. ; the first funicular joint shorter than the second ; sense-organ on scape more basal in position and shorter than in *S. glossinae.*

Length, 1 mm. ; alar expanse, over 2 mm.

S. phaeosoma may be separated from *S. glossinae* by the colour, proportions (♂, ♀) and sense-organ (♂) of the antennae (fig. 7 *c*, *d*) ; the chaetotaxy of the mesonotum and the shape of the propodeon ; the sculpture and colour of the abdomen ; the colour and breadth of the wings ; the colour of coxae and the proportions of the mid tarsal joints.

SECOND REPORT ON GLOSSINA INVESTIGATIONS IN NYASALAND.

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(Plates IV and V.)

Until 13th March I remained in the Proclaimed Area, then, as the weather conditions were very bad, and as moreover the grass had so overgrown all the paths, which are little used, that my movements were very much hampered, I removed to Fort Johnston at the southern extremity of the Lake, and have since been working in its neighbourhood.

Some preliminary tramps were necessary for the purpose of finding out the locality most suitable for the work, and accordingly in late March and early April, when the rains were just over, I took the opportunity of studying the distribution of *Glossina morsitans* on the east side of Lake Malombe ; then to the south of Chingaras, a large village 25 miles south of the Fort on the main road to Zomba ; and finally, along the west side of Lake Nyasa as far as Monkey Bay, 25 miles north of the Fort, where, as the fly was more numerous than elsewhere, I decided to continue the work.

The outcome of these expeditions was to revolutionise the ideas which I had obtained by reading as to the distribution of the fly at this season, for though in none of these localities were they as numerous as in the proclaimed area, isolated flies were found over a very wide range. Thus, in the course of a six hours' trek from Fort Johnston to Malombe, a distance of some 20 miles, I took five ; two in the early morning when I first set out, many miles from where I subsequently found them to be numerous. On the journey from Fort Johnston to Chingaras, a distance of 25 miles, I took four in country hitherto considered free from them ; and on the journey from Monkey Bay to Fort Johnston, which I have made several times, I have always been able to take one or two flies many miles from the locality in which I know them to be numerous. Such isolated flies are always very unobtrusive, and as they do not necessarily bite, though persistently following one, it is probable that they escape the untrained eye. In the proclaimed area the physical conditions of the country—the Lake to the east and a range of hills, devoid of trees, to the west—make the term " fly belt " applicable ; but in the Fort Johnston district there was nowhere at that season anything approaching a hard and fast line marking the distribution of the fly, which indeed seems to occur under widely differing conditions.

Its distribution in varied types of country was well exemplified in the " fly belt " of the proclaimed area. Here on travelling due west from the Lake one passes first of all over a dambo [open swampy land], where of course there are no fly ; then through scattered Borassus palms, which at a distance of about $2\frac{1}{2}$ miles from the Lake grow thickly, with low shrubs, and tufts of comparatively low wiry grass in between (Plate iv, fig. 1). The soil is very sandy, such being favoured by these palms ; and here the fly begins. Further on, at a distance of two or three miles more, the sandy soil gradually gives place to a heavy black soil, very tenacious in wet weather, and there is a marked change in the vegetation, the palms becoming fewer and fewer till they give place entirely to large shade trees, baobabs and lower

bushes not of a thorny nature, while the grass is so high that for seven or eight miles one simply tunnels through it, with no possibility at all of seeing the surrounding country (Plate iv, fig. 2). Thorn trees then gradually appear and the grass gets lower, till at the end of another two or three miles one gets into thorn bush country, where there are few other trees. The soil here is inclined to be hard and clayey, though areas containing a considerable amount of sand are seen from time to time. With a gradual rise of the ground, beginning at about fifteen miles from the Lake, rocky outcrops appear, the thorn bushes becoming twisted and stunted in growth (Plate v. fig. 1); and finally, at an altitude of about 3,000 feet, only a few scattered shrubs are to be seen, so that practically open country is reached.

In all these varied regions, except the last, *G. morsitans* is to be met with, though in greatest abundance where the thorn bushes and the large trees are thickest.

When the grass is high, the flies, like the ticks, are most numerous along game and native paths; though, as is the case when the grass is low, their distribution varies from day to day.

Proportion of the Sexes.

My experience in this matter is the same as that of other observers, namely, that when the flies are bred out from pupae, the sexes emerge in almost equal proportions; and when the flies are captured, the males far outnumber the females. A theory which might account for this is that the females have different feeding habits from the males, possibly feeding better with an overhead sun, or when the sun's rays are more oblique. To test this a series of captures were made for several days at three different periods of the day, viz.: from 8 to 11, from 12 to 3, and from 3 to 6. The proportion of the sexes was found to be practically the same in each case.

A further theory which then occurred to me was that the distribution of the sexes in a given area might not be quite the same, and this theory seems to some extent to be supported by actual facts. Differential captures at the centre of a tsetse area, and at its margins where the flies are more scanty, do show, though statistics are as yet meagre, that the females are more abundant at the outskirts; and in the search for pupae in regions which the fly has temporarily vacated, it has been my frequent experience to be assailed by a solitary pregnant female.

There are very definite reasons why the female flies should to some extent shun the society of the males. As I have before remarked, and have since repeatedly observed, coitus takes place as a result of capture without preliminary courtship. Moreover, when, as often happens, little knots of flies in a confused buzzing swarm of four and five appear suddenly in one's vicinity, repeated captures have shown the group to contain one female, and one only, the obvious interpretation being that the female wishing to feed, has been chased by the males. Furthermore, on putting a newly emerged female, even with its wings still flaccid, into a jar containing males and an adequate supply of the other sex, it is almost the rule for the female to be seized immediately by one of the males, which sooner or later after a struggle accompanied by loud protest effects coitus; and it occasionally happens that two males will seize the same female.

In captivity even females in an advanced state of pregnancy are not secure from the violence of the males, and as abortion is so frequent with captive females, it seems

possible that this may conduce to it. Latterly, therefore, it has been my practice to keep such females apart from the males, the results obtained justifying the correctness of the conclusion. It often happens also that a male will become securely locked to a recently dead female, and Dr. J. B. Davey, of the local medical service, informs me that he has repeatedly witnessed a similar occurrence.

These facts undoubtedly indicate the necessity for the pregnant female to seclude herself, when once fertilised, from the further attentions of the males ; hence the unequal proportion of the sexes among captured flies.

If this supposition be correct, a comparison of the proportionate numbers of the sexes caught during the breeding season, and when breeding is not going on to so great an extent, should yield evidence bearing on the question. There are not, so far as I am aware, statistics dealing with the breeding habits of the fly in Nyasaland, and as the seasonal conditions are probably different from those of Rhodesia, an examination of such data obtained there is not likely to shed much light on the question here. I am, however, sure that the flies just now in the early dry season [beginning of June] are breeding more freely than they did when the rains were on in February, and a consideration of the relative proportion of the sexes taken over a given period of time at the two seasons does afford some slight evidence in support of the supposition, the females in February forming 15 per cent. of the total captures, and in May 5 per cent. The actual figures are given in the following table :—

Table showing Proportion of Sexes in captured G. morsitans.

Locality.	Date.	Males.	Females.	Remarks.
Lingadzi	3.ii.15	150	16	Wet season.
,, ...	4.ii.15	129	19	,,
,, ...	5.ii.15	231	22	,,
,, ...	6.ii.15	111	24	,,
,, ...	7.ii.15	142	32	,,
,, ...	8.ii.15	128	21	,,
,, ...	10.ii.15	130	25	,,
,, ...	11.ii.15	183	35	,,
,, ...	12.ii.15	163	23	,,
,, ...	13.ii.15	116	11	,,
,, ...	15.ii.15	118	12	,,
,, ...	16.ii.15	186	24	,,
	Total ..	1,788	264	15 % (almost) of females.
Monkey Bay	11.v.15	143	5	Dry season.
,, ...	12.v.15	282	28	,,
,, ...	13.v.15	136	4	,,
,, ...	14.v.15	76	11	,,
,, ...	16.v.15	113	10	,,
,, ...	17.v.15	103	3	,,
,, ...	18.v.15	128	5	,,
,, ...	21.v.15	80	4	,,
,, ...	22.v.15	215	5	,,
,, ...	23.v.15	99	5	,,
,, ...	24.v.15	152	4	,,
,, ...	26.v.15	71	0	,,
	Total ..	1,598	84	5 % of females.

Predaceous Enemies.

A species of dragonfly (*Orthetrum chrysostigma*, Burm.) the male dull blue in colour, the female greenish blue has now been found to prey on *morsitans*. In February, in the Lingadzi district, I saw one of these dragonflies, which had been following and hovering round the party of six boys with me, suddenly swoop down and take a tsetse from the back of one of the boys who was stooping at a pool to drink, its movements being extremely rapid. It settled on the grass near by and commenced to devour its prey. Later on I saw a dragonfly of the same species take a *morsitans* which had rested on a blade of grass, though again I was unable to see whether the capture was effected on the wing or not; and on the following day I saw another capture a tsetse off a boy. A fact of importance in all three cases was that each dragonfly accompanied our party for some little distance, obviously expecting to find its prey in our vicinity.

I have further studied these dragonflies in relation to *morsitans* in the Monkey Bay district. They have been observed repeatedly to flit round passers-by as if in search of prey, settling near by if unsuccessful. When a number of people are walking in Indian file, it is quite common for the insects to make a search round each, often following on a short distance behind, and I have without any difficulty caught a number of specimens with their prey, in most cases tsetses, taken in the neighbourhood of natives accompanying me.*

When a dragonfly has appeared at such times as there happened to be no tsetses about, further light as to the object of its presence has been obtained from time to time by flicking off one's hand a tsetse with one wing clipped. So fleet are they on the wing that in a number of cases the tsetse was seized before reaching the ground. By this method it was ascertained that tsetse-flies, whether half starved or replete with freshly ingested blood (either from a goat or a fowl) were equally acceptable to the dragonfly, and after eating a replete tsetse the dragonfly has been found to have the blood smeared abundantly over its face and jaws. The insect is indefatigable in its work, and both sexes are to be found on the move in glades, in open grass country, and on rocky barren soil far from water, whether early or late, in sunshine or bad weather. The females feed and oviposit readily in captivity, the eggs, which are numerous, being arranged in irregular masses.

I have kept a look out to determine whether any other species of dragonflies habitually prey on tsetses. Only one other instance occurred, and in this case the insect (*Crocothemis erythraea*, Brullé) handled the tsetse-fly so clumsily, gradually slipping down and right round the grass stem to which it was clinging, in a vain endeavour to hold its prey and support itself at the same time, as to convince me that it was quite a novice with tsetses.

Observations on the Larvae of Glossina.

As has been already noted by previous observers, the newly born larva is covered with a clear slimy secretion, and a theory has been advanced that the purpose of this is to cause earth to adhere so that the pupae are less readily recognised by

* [Dr. Lamborn has sent notes of 21 cases in which he saw these dragonflies take tsetses on 23rd and 24th April and 3rd–12th May 1915.—Ed.]

scratching animals. This supposition has not seemed to me to be tenable, seeing that one never finds such a covering, however carefully one digs up the pupae ; and moreover, though a certain amount of dust does cling to the pupa, it is invariably in the form of minute particles only in the neighbourhood of the intersegmental rings.

A more likely supposition has seemed to me that the secretion might have a protective function, the period between the birth of the larva and its burying itself in the ground, during which it crawls on the surface, being probably the most critical in the life-history of the fly. Ants are invariably found in the breeding places, and as they depend so largely on insect food, a series of experiments have been conducted with a view to finding out the attitude of various species towards the larvae. Those selected first for the experiment were a small black Myrmicine [*Pheidole megacephala*, F.]. These usually run about singly, and though repeated trials were made, in no single instance did a solitary ant, or even two or three together, attempt to molest the larva, the usual procedure being for an ant, having examined it with its antennae, to back away and run off on other business. When, however, a larva was placed close to a nest of these ants well stirred up, several invariably attacked it, but in a short time relaxed their hold and cleaned their antennae, though others then seized it. The same results were obtained with another Myrmicine ant *Pheidole lieugmei*, For.].

In the case of another ant [*Cremastogaster chiarini*, Emery], a larva was placed close to a large party engaged in the work of dismembering a big cockroach. Two or three having investigated it with their antennae retired, but after a time one large one seized it by the black prominences at the posterior end and held on for some seconds till three or four others came up and gripped it elsewhere. It was obvious that they were by no means happy with their prey, for they let go one after the other, cleaning their mandibles, but by and by again seized it. These ants are not, however, found in the breeding places, as they favour more open situations.

The only really definite results were obtained with the small Ponerine ants [*Euponera senaarensis*, Mayr],* one of which on several occasions uncompromisingly seized the larva and ran off with it.

From these results I think that a reasonable inference may be drawn that the secretion is protective against such ants as are usually found in breeding places. It is probable also that it is of material advantage in protecting the delicate cuticle from injury as the larva makes its way down to its future resting place in the soil.

Parasites of Glossina morsitans.

The large number of Mutillid wasps in the Lingadzi district attracted my attention from the first, and I endeavoured during my earlier days here to parasitise tsetse pupae with them, but without success. Long series of the smaller species, which seemed suitable, have been sent home.

In late May, however, two Mutillids, a male and a female, which I have since learnt from the *Bulletin* are *Mutilla glossinae*, Turner, were bred out from pupae found in the vicinity of Monkey Bay, and a good series have now been obtained, 6 males

* [Mr. W. C. Crawley kindly identified the ants forwarded by Dr. Lamborn.—Ed.].

and 10 females having been bred out. The tsetses which have emerged from the 1,143 living pupae which I have obtained since 10th April number 54 males and 71 females.

The appearance presented by a pupa-case from which a Mutillid parasite has emerged seem to me characteristic and unmistakable, though a contrary opinion has recently been expressed (Eminson, quoted in Bull. Ent. Res., v, p. 382). On taking such a case in the fingers there is, owing to the presence of the *Mutilla* cocoon within, a sense of greater solidity than when a fly has emerged, and it is possible by gentle pressure to crumble away the wall of the puparium so as to obtain the cocoon, a light chestnut-coloured structure composed of several layers of a very tough silky-looking material. The orifice of exit is usually much smaller and has a serrate edge, instead of the larger clean-cut fracture produced by the emergence of the fly, owing to the parasite having nibbled out a circular cap, and one can always see the walls of the cocoon within. In the course of time the cocoon tends to shrink, the result being that it draws in with it the margin of the hole of exit in the pupa-case, so that this is no longer circular but somewhat oval, a condition never seen in the case of a normal puparium

There has been no difficulty at all in dealing with the Mutillids in captivity, for all, except two, one of which was accidentally drowned, are still alive now, one or two of the earliest specimens being several weeks old. The original male placed in a box with the female shortly after the emergence of the latter manifested the greatest excitement, running about with its antennae on the ground on the track of the female, which it overtook after a considerable chase and immediately seized, pairing taking place almost at once. It is noteworthy that in the course of the chase it ran repeatedly very near to the female, but being off the fresh track did not detect it, the sense of sight being evidently of very little help to it in the matter.

Various pairs have been kept in captivity in jars containing a number of tsetse pupae buried in earth, in the hope that the females would sooner or later parasitise them. This expectation seems likely to be fulfilled, as on 30th May the first female, which emerged so long ago as the 3rd of that month, was actually witnessed ovipositing in one of the pupae. As the manner in which oviposition was effected presented features of interest, I jotted down at the time a full note concerning it, which I now transcribe:—At 5.45 p.m., on coming into camp from a day's trek, I removed from inside a box, which had been closed all day, a jar containing the *Mutilla* female, no. 1, and a number of tsetse pupae, mostly buried in earth, though one or two were on the surface. On the top of one of the latter the *Mutilla* was seen. It remained still a few seconds, then precipitately vanished beneath a lump of earth, as is their habit when alarmed. In a few minutes it came out into the open again cautiously, and after examining with its antennae some pupae near the one on which I had first seen it, started, with its head facing the tail end of the pupa, to whittle away with its jaws at a point midway between the two poles with such energy as to rock it. Its antennae were crossed and below its head. After five minutes' work in the horizontal position it gradually raised itself vertically, with its head down on the pupa, supporting itself against the side of the jar, so that a full view of its movements with a lens could readily be obtained. Extremely fine movements of the jaws in and out took place with great rapidity and with such

delicacy that unless one's attention had been attracted by corresponding movements of the labial palpi the operations in progress would have been undetected. From time to time a sharp turn of the head through a quarter of a circle on each side also went on.

After half an hour's work the *Mutilla* retired a short way from the pupa and, resting on its side, cleaned its antennae and rubbed its legs together, but then manifested some uneasiness at the light, for at this point I had to watch it by lamp light, and concealed itself. But when the light was very much shaded, it returned to the pupa, put its head to the site of its previous operations, where with a lens I could see a small breach of surface, and then gradually raising the hinder part of its body so as to rest again on its head, recommenced work, its antennae being this time in front of its head, but resting on the pupa. Occasional movements of anteflexion of the abdomen then took place, as if the insect were preparing for oviposition, and finally, after at least an hour's work, the insect resumed the horizontal attitude on the pupa, and having examined its work advanced so that its hinder end came somewhere over the breach. It then moved to and fro, feeling for the exact spot, and then remained still, doubtless in the act of oviposition, running away a few seconds later.

Though the female worked so indefatigably, so tiny a puncture was produced as to be barely visible except in a certain light to the unaided eye, and it appeared moreover as if definitely sealed by the insect with some secretion after oviposition. This may possibly be a very important part of its final operations, as on several occasions I have found an exuberant fungus growth, brown in colour, sprouting at little fissures accidentally produced in tsetse pupae. By and by I hope to be able to study this further.

I should perhaps add that the night when the *Mutilla* was working was bitterly cold, a rather surprising fact, seeing that as a rule these insects are so lethargic except on bright sunny days.

I have now examined carefully all the pupae to which this female has access, and seven out of the twenty show this evidence of attack. There is therefore every reason to believe that the *Mutilla* can be raised experimentally in some numbers and without any great difficulty in the laboratory. Their hardiness, their activity in finding food for themselves and their longevity make them singularly easy to deal with, so that I expect shortly to be able to submit a further report on the subject.

In regard to their general habits, they do not as a rule become active till the middle of the afternoon, remaining until then hidden beneath objects on the top of the ground, or buried beneath the superficial layers of the soil. The female is an adept at burrowing, and the male in pursuit of her does not hesitate to force his way into the soft earth. Both sexes run with extreme activity, the male being unusually loth to take to flight for a winged insect. The females in captivity soon lose the quality of shyness, which is so marked during the first day or two after emergence, and will then run about unconcernedly, even though one is moving objects in the jar, almost as if they had learnt that they were unlikely to be molested.

A species of Bombyliid fly (*Thyridanthrax abruptus*, Lw.)* a striking-looking insect, quite distinct from the *Villa lloydi* found also to be parasitic on *morsitans* pupae in Rhodesia, has been bred out from *morsitans* pupae here, three specimens having been obtained. The first of these insects was discovered in early May in a jar containing a number of tsetse pupae which had been buried beneath the earth. The pupa-case of the *Thyridanthrax* was found on the surface, and I therefore concluded that perhaps the pupa, having escaped notice, had been in the earth all along and had no connection with the tsetse pupae. But since this I have been keeping my pupae in rice to prevent them from rolling about when the boxes are moved, and in these I found two more of the Bombyliids a short time ago, their puparia being far removed from the tsetse pupae which they had originally occupied. The empty tsetse puparia differ in no way from those from which tsetses have emerged, other than in the absence of the cuticle which is found in the latter.

This Bombyliid is by no means uncommon in the fly area, especially at Lingadzi, so that I have been familiar with its appearance almost from the very first. I am endeavouring to proceed further with an investigation into its habits.

Within the last few days two nice-looking Chalcids [*Stomatoceras micans*, Wtrst.], large insects with black markings on the wings, have emerged from tsetse pupae through an opening situated in each case close to the tubercles at the posterior end of the puparium. These also are thriving in captivity, but unfortunately appear both to be of the same sex.

In connexion with the question of Chalcids, I found in April in cattle droppings a large number of pupae of a little Muscid [*Musca* sp. nov. ?] common in houses in this country, and having bred out numerous small Chalcids [*Spalangia* sp.] from them, endeavoured to parasitise tsetse pupae with them, but without result, so far as I have yet been able to judge.

A fourth species of parasite, an apterous insect,† has also been bred out from a tsetse pupa.

Examination of the living pupae recently collected, 1,143 in all, affords evidence as to the probable parasitism of a small number, small marks like punctures being visible with a high power lens, and a study of the empty cases found at the same time, numbering 9,762, has afforded some statistics thereon, for owing to their chitinous nature and the sheltered positions in which they are placed it appears to be some time before the empty cases suffer by exposure. By far the greatest number of cases (no less than 8,543) had given exit to perfect flies ; for though there is no means of differentiating between normal pupae and those parasitised by Bombyliids, the latter seem to be in so small a minority as to be almost negligible from the statistical point of view ; 351, or $3\frac{1}{2}$ per cent., showed that they had been parasitised by Mutillids, the features characteristic of which have already been

* [This species was bred from a *G. morsitans* pupa in Southern Rhodesia, in November 1912, by Mr. R. W. Jack. In Nyasaland, it was found in Mombera's district by Dr. H. S. Stannus, and in North Nyasa by Dr. J. B. Davey. It has also been received from Embu, Mt. Kenia, British East Africa (*G. St. Orde Brown*) and Minna, N. Nigeria (*Dr. J. J. Simpson*).—Ed.]

† [This is a new and remarkable Chalcid, which will shortly be described by Mr. J. Waterston under the name of *Eupelminus tarsatus*.—Ed.]

described, the parasite having in practically every case escaped at the cephalic end ; 107, roughly 1 per cent., were intact, except for a pin-point hole at one side, produced in all probability by the escape of some tiny parasite, possibly a Chalcid parasitic on the Mutillid, for a few of these which were broken open showed the remnant of the cocoon of the latter ;* 264, roughly 2 per cent., show larger rounded holes produced by the escape of a parasite, some at the posterior end, others to one side, the insect being in all probability one of the large Chalcids. Some twenty, a few of which had contained Mutillids, showed evidence that the pupal contents had been eaten from outside ; and 477 were so damaged that it was impossible to form any opinion as to their history.

No parasites whatever have as yet been bred out from pupae obtained in the proclaimed area,† all that have been obtained hitherto having emerged from pupae found in the vicinity of Monkey Bay, a fact which may explain the numerical superiority of *morsitans* in the former region.

Breeding places.

Until April the search for breeding places had been almost without result, five pupae only having been found in hard clayey soil. But since then they have been obtained in large numbers, as the result of realising that the condition of the soil is one of the all-important factors in determining whether or not a particular spot will be selected by the female.

As pointed out by Mr. Lloyd, the fly seeks some relatively dark and shady spot. Many such are to be found in a tsetse area, mostly under fallen trees ; but in my experience, which is now considerable, being based on an examination of 512 breeding places, few, if any, pupae will be found unless, in conjunction with the shelter, the soil is likely to be dry at all seasons, having no hard top crust, such as is formed under the influence of moisture and sun, and containing sand and decaying wood or other vegetable matter so as to make it light. In nearly every instance the breeding places have been situated beneath a fallen and well decaying tree, which has been prevented by some of its limbs from actually touching the ground, and is of such girth as to keep an area beneath it shaded and free from moisture. The soil in such a place being leavened by humus becomes light and friable, so that the larva can have little difficulty in making its way into it.

Very few pupae have been found in hard clayey soil beneath trees, and as it has been found experimentally that the larvae have very weak boring powers, being unprovided with bristles, their occurrence in such situations is probably purely accidental, the parent fly having possibly failed to find a suitable place in time for the birth of its offspring. Such soil, moreover, in the dry season dries almost as hard as stone, needing such considerable force to break the top crust as would render it almost impossible for the newly emerged fly to break its way to the surface.

* [A large number of these Chalcids were bred subsequently by Dr. Lamborn from a tsetse pupa and proved to be *Syntomosphyrum glossinae*, Wtrst. There seems little doubt now that this species is harmful, being a hyperparasite of *Mutilla glossinae*.—Ed.]

† [If this observation is confirmed, it may prove to be of considerable practical importance, for the introduction of parasites from Monkey Bay would probably in that case have a material effect upon the numbers of the fly in the proclaimed area.—Ed.]

Some few pupae have been found under trees in accumulations of dead leaves on the surface of the ground, but so few, that this again is probably purely accidental. Pupae in such situations seem to stand little chance of survival, for repeated experiments made by exposing bred ones in similar surroundings in the hope of getting them parasitised, have resulted in the loss of the majority, some undiscovered insects, possibly cockroaches, which one finds not infrequently, having eaten out the pupal contents.

As has already been pointed out by workers in Rhodesia, pupae may be deposited in cavities in dead limbs of trees, a certain amount of soil, the result of the admixture of earth originally brought by termites with wood debris, being invariably found in such situations (Plate v, fig. 2).

The question of soil in the various breeding places has been studied, but no special sort seems to be favoured, the chemical constitution being immaterial, so long as the soil is friable. All the trees also, in relation to which pupae have been found, have been carefully examined with a view to ascertaining whether one species more than another is favoured by the fly. In the majority of cases decay has been so far advanced that the determination has been out of the question, but in 48 instances specimens of the foliage, representing at least fourteen species, have been obtained and are available. In five cases a few pupae have been found under the shelter of a fallen Borassus palm.

Further study of the question has shown that the presence of a dead tree is by no means essential, for in certain parts of the Monkey Bay district breeding grounds sheltered by overhanging rocks have been found, each yielding from two or three to as many as ten pupae (Plate vi, fig. 1).

Attention has been paid to the orientation of all these places, the conclusion arrived at being that this is immaterial, all that is apparently required being that the breeding places should be sheltered from the overhead sun.

The conclusions arrived at from my study of the question are that the only essentials inducing a female tsetse to select a particular spot are looseness of the earth and shelter. In Nyasaland, as in Rhodesia, the situations most favoured are near game and native paths, and near water-holes (Plate vi, fig. 2), whereby the newly emerged fly is in the most favourable situation for obtaining food in the shortest possible time after emergence. Beyond this, the choice of a site by the parent fly is not in my opinion influenced by any special type of soil or of vegetation. The insect fauna in breeding places has been studied as digging has proceeded. It is never very numerous, the only frequent occupants of such places being small blackish Myrmicine ants [*Pheidole megacephala*, F.] and the larvae of ant-lions. Small cockroaches and their oothecae are not uncommonly found, and also the pupa-cases of the large Ponerine ant, *Paltothyreus tarsatus*, F., which insect is frequently seen transporting its pupae and probably deposits them in such a situation as being sheltered.

It is by no means uncommon also to find small lizards and geckos, which doubtless take some toll of pregnant and newly emerged flies. But the fly is able to run with such great activity for a short distance as to make it a matter of some difficulty

to secure a newly emerged insect with one's fingers. This doubtless favours the escape of such insects, and of the pregnant females, which take to flight unwillingly and fly heavily.

No evidence has been seen that any scratching animals habitually seek food in such places, the various Grallatores—francolin, partridge, and guineafowl—which abound in the tsetse areas, preferring more open places, especially where game is in the habit of resting.

Early in June I returned to the proclaimed area for the purpose of ascertaining whether pupae had been deposited under trees already felled in the district.

With a view to minimising the numbers of *morsitans* along the road running west from Domira Bay, the Government cleared in the middle of last year an area averaging a hundred yards in width on either side for a distance of about eight or nine miles. I may remark incidentally that in January the Resident, who was responsible for the clearing, gave it as his view that the measure had been productive of some benefit. The Medical Officer however, who knows the district well, expressed a very contrary opinion, and I myself found the flies abundant in places and extremely troublesome, though the country was a blackened wilderness as a result of grass fires. Later on, in March, the tall grass and the new shoots put out by the tree-stumps formed abundant shelter for the fly.

By the clearing process all trees, whether large or small, were cut off at a height of about two feet from the ground, and many, which had fallen before the trunk had been completely severed, rested at one end on the stump, a condition which seems to form beneath an ideal kind of breeding place for the fly. Hundreds of such places now exist there, and as there seemed to be a strong probability that the fly might use some of them as breeding places, I have examined a large number and have ascertained this is actually the case. Pupae in small numbers were obtained under a large number of trees—on 8th July for instance, an unusually good day, 30 living pupae and 162 pupa-cases were found—and doubtless as time goes on and the earth under the trees becomes looser, more and more will be obtainable, for the grass fires of this year have done little towards consuming these trees, though they were felled as long as a year ago. My observations there confirm my previous experience, that no special tree is favoured by the fly, which conclusion is further supported by the discovery of a few pupae in wood ash beneath trees which have been partly burnt by grass fires. There is thus no question as to the feasibility of constructing artificial breeding places.

A further fact of importance is that many of the pupae are to be found in a part of the area from which, concomitant with the drought, the fly has temporarily receded, a point which any scheme for dealing with the fly will require to take into consideration; and there is also the possibility that pupae so situated may remain quiescent in the soil during the greater part of the dry season, the flies emerging and repopulating the area when a change of season takes place.

A large number of tsetse pupae found at Monkey Bay in late April, ten weeks ago, are still alive, so far as I have been able to ascertain by opening one or two,

and indeed every day or two a fly comes out from among them. The discrepancy in the accounts given by other workers as to the length of pupation (47 to 53 days, Kinghorn, in Bull. Ent. Res., ii, p. 295; and 23 days on an average, Lloyd, in Bull. Ent. Res., iii, p. 95) would seem to support the conclusion. In February of this year (the wet season), a family of flies (*Sarcophaga* sp.), which I bred from one parent with a view to studying parasites, all emerged on the same day and at the same hour, whereas from the pupae of a second family bred recently in the dry season only five out of twenty-three have as yet come out, and those three weeks ago; this strongly suggests that aestivation is proceeding. On the west coast of Africa it certainly occurred in the case of a Muscid allied to *Lucilia*, and was of course the regular occurrence with various species of Lepidoptera.

Flight Experiments.

In passing from a *morsitans* area into country apparently free from them, whether bush or open country, it has always seemed to me that the same tsetses which have been hovering round continue to follow for a considerable distance. With the object of deciding whether such flies do really attend one and are not chance new-comers, a series of experiments have been conducted, consisting in liberating marked flies at a definite point, and then after a walk to various distances capturing all those in the immediate neighbourhood.

The results obtained afford positive information on the point, but in regard to the actual numbers of the flies recaptured there are of course several conceivable fallacies. For instance, possible variation in the walking pace on each occasion, though it was as uniform as possible; possible impairment of the insects' powers of flight, as a result of injury during capture; the influence of wind and of climatic conditions on each occasion, etc.

The first series of experiments, which I give below in table form, was conducted in the neighbourhood of Domira Bay and consisted in releasing the flies where most were originally taken, in palm country towards the east, and then returning to the Lake shore, a distance of $2\frac{1}{2}$ miles, mostly across dambo [open grass land] and capturing as many as possible. On every occasion a breeze was blowing from the direction in which my party was proceeding.

Date.	No. of males released.	No. of males recaptured.
2.iii.15	20	3
3.iii.15	20	1
5.iii.15	20	4
6.iii.15	20	3
8.iii.15	20	1
9.iii.15	20	2

The second series of experiments given in detail in the table below, was carried out at Monkey Bay and consisted in liberating marked flies at the outskirts of bush country favoured by tsetses and then recapturing as many as possible at definite distances along a native path, which, like all these paths, was very devious, winding in and out among thorn bushes.

In connection with the whole question it is noteworthy that motor cyclists coming into Fort Johnston commonly assert that the flies, which are abundant some thirty miles to the south along the Zomba road, settle on their backs and are so brought into the Fort. Residents confirm the statement, and it is therefore possible that the large increase of motor traffic, which has taken place as a result of military measures in the country, may be indirectly responsible for the high mortality of the cattle from trypanosomiasis which has occurred during the past few months at the Fort, and may account for the occasional discovery of a stray tsetse in the houses there.

Date.	No. of males released.	No. recaptured.	Distance traversed.
12.iv.15	100	13	½ mile.
13.iv.15	100	16	1 „
17.iv.15	100	3	1½ miles.
18.iv.15	100	20	1½ „
22.iv.15	100	12	1½ „
23.iv.15	100	19	1½ „

I have made a third series of flight experiments in the proclaimed area, releasing marked male flies, as before, at a spot two miles south of the Lipimbi river, at an altitude of 1,950 feet, and recapturing as many as possible in the region from which they had been removed, namely Lingadzi, about five miles distant in direct line, with an altitude of 1,700 feet. The country which they had necessarily traversed in their return consists of thin woodland composed of thorn and other low trees growing in rocky arid ground, in which area flies have from time to time been found, though never in any great numbers, the region to which they returned being characterised by the greater fertility of the soil, which is far less rocky and sandy, by the greater luxuriance of a similar type of vegetation, and by the presence of a greater amount of surface water, as a result of which game is much more abundant.

In making these experiments every precaution was taken to guard against possible fallacy. The flies were liberated by placing the cage in a tuft of grass before opening the door, by which means it is possible for the person conducting the experiment to get away to a distance before any flies are able to follow. In no case did the person releasing them return to the tsetse area, and there was very little probability of any flies returning on the backs of chance passers-by.

The results of these experiments are given in the following table: —

Flies released at Lipimbi R.		Flies recaptured at Lingadzi.	
Date.	No. of flies, all males.	Date.	No. of flies recaptured.
3.ii.15	146	4.ii.15	3
4.ii.15	129	5.ii.15	1
5.ii.15	231	6.ii.15	1
6.ii.15	111	7.ii.15	2
7.ii.15	142	8.ii.15	1
8.ii.15	121	10.ii.15	1
10.ii.15	130	11.ii.15	1
11.ii.15	183	12.ii.15	2
12.ii.15	163	13.ii.15	1
13.ii.15	116	15.ii.15	2
15.ii.15	118	16.ii.15	1
16.ii.15	186	17.ii.15	1

General Observations.

I have repeatedly seen flies settled on wet sand, for the purpose I imagine of drinking, though as the fine proboscis only is lowered while the palps remain in the usual position in front of the head while the insect is feeding, and as it does not permit one to approach very near, it has been impossible to settle the point. I have endeavoured to study the matter further by starving flies in captivity, providing them only with wet sand, but even though they survived longer than a similar number kept entirely without water, I was not quite sure even then that they did drink, though I thought I saw one or two do so.

I have endeavoured to test also whether flies ever drink dew, and whether they will feed on various fruit juices, saline solution, etc., but have not obtained any positive results.

Though there seems to be some evidence that the flies are attracted to a moving object through the sense of sight, I have found repeatedly that if well starved flies with one wing clipped are released in long grass, they will make their way by running to a person sitting at a distance of ten to twelve feet, whom it is impossible for them to have seen. The sense of smell therefore must play an important part in leading them to their prey. But the smell of fresh blood does not have the effect of attracting flies, for I smeared the blood of a freshly shot duiker antelope, and on another occasion the blood of a fowl, on trees in the fly area and none came to it, though there was a breeze blowing and a fair number of flies were in the neighbourhood.

Conversely, flies with their antennae snipped off at the base with fine scissors, which does not seem to make any material difference to their well being in captivity, have been found in a few instances to make their way to a moving person from a short distance, ten to fifteen yards.

A further series of flies following at one's heels in the early morning and evening and settling on the ground from time to time, but not attempting to bite, have been secured ; all have been males. As has been repeatedly noted by other observers, male flies settle sometimes on one's back and do not attempt to bite, an occurrence in my experience more frequent in the heat of the day. The interpretation of this habit is, I believe, that the ground, which is then so hot as to be unpleasant even to the feet protected by thick boots, is too scorching for the flies, which then avail themselves of the coolest situation convenient. I have endeavoured to obtain some evidence as to whether such flies really are on the look out for females only, by causing boys to carry on their backs as they walked through fly country newly emerged female flies gummed by the legs on brown paper, but no results were obtained, though as the male seizes the female while on the wing, no negative inference can be drawn from the experiment.

Observations on Glossina brevipalpis.

This species was found in February to occur in a very limited area in the centre of the Lingadzi estate, which is situated on either bank of the river of that name, about eight miles from Lake Nyasa. The estate is surrounded on three sides by dense bush, but towards the east is more open, consisting of thin woods interspersed with dambos. It was at one time used as a cattle station, but the enterprise was abandoned some years ago owing to the advent of *morsitans*, and now a limited portion only, some ten or twelve acres, is under cultivation for fruit.

G. brevipalpis to the number of ten to fifteen, all males, were taken night after night at about dusk in the fruit garden within an area of about fifty square yards, mostly along a path running through it from the bank of the river. The fruit trees growing at the spot were bananas, mangoes, and citrus fruits ; three large indigenous trees, one evidently allied to our plane tree, being the only others therein. The area was devoid of weeds and undergrowth, except for a broad belt of coarse high grass growing in the mud of the river bank. The soil was a well-drained rich black humus, except along the path, where, owing to the lighter portions having been washed away, some sand was in evidence.

A systematic and very careful attempt was made day after day to discover why the fly was present and in so limited a space, but no light was obtained on the question. As the rains were on there was no difficulty in examining the spoor of animals passing through the area, and this was done for a fortnight. The foot-prints of duiker antelope were found very commonly, and on one occasion those of a kudu, and so far as could be ascertained these were the only large animals which passed through it during this time. Toads occurred in some numbers, and an attempt was made by keeping some in captivity to ascertain if the flies ever fed on them. They did not do so, but were gradually caught and eaten by the toads. An endeavour was made also to ascertain if the flies would feed on fruit and fruit juices, but no results were obtained.

No female flies at all were taken among a total of 119 flies, neither were any pupae found, though sought for in every conceivable situation—at the bases of all the trees, high up in the forks of the larger trees, in the debris around the bananas, in the

sandy soil of the path and in the mud of the river bank. A few females were found in the daytime, resting low down on the tree-trunks, and one was taken at 10 a.m. in a well shaded nook off the leg of a boy who called my attention to it, saying that it had bitten him, and I found that it was distended with fresh blood.

Fifteen of the flies were placed in captivity on 12th February and were afforded an opportunity daily of feeding on the blood of a goat. On this diet they throve for fourteen days, during which two only died ; then a large number of small black ants made a raid on them and killed nine before they were discovered. The remaining three died off one by one, the last nine days later, having accordingly lived on goat's blood solely for twenty-three days.

The other habits of the species were found to accord with those described by other observers.

An attempt was made by releasing marked flies near by to ascertain whether they would return to this particular spot, but none were ever recovered.

Later on, an opportunity was taken to study *Glossina brevipalpis* in its haunts nearer Lake Nyasa. The locality there affected by it lies for some three or four miles along the Lake shore between the two mouths of the river Lingadzi, and on either bank for three or four miles inland, and it is characterised by the great density of its vegetation, a large variety of shrubs, herbaceous plants, and tall grasses, all laced together by several species of convolvulus, and leguminous climbers, the irritating Mucuna bean in particular, growing beneath large trees of the Acacia type, from the branches of which depend lianas. The bush is here far thicker than I have seen it elsewhere in the country and reminds one of that seen in the coastal belt of tropical West Africa.

The soil is light and sandy, and contains even now, after four months drought, plenty of moisture, so that along paths cleared only three weeks ago the young grass is already ankle-high and I am informed that it is not as a rule possible to burn it off till October or November, when the rains are again due.

There are several villages, the inhabitants of which have cleared large garden plots, and in some of these even at this season young maize, planted in depressions hollowed in the ground, is thriving, though rather dwarfed in growth.

This bush is traversed by numerous winding game paths, and it affords shelter to a large variety of game animals, in fact, I found the fly first along a game path down which a herd of waterbuck had just passed on their way to the lake.

I believe that the presence of this species of fly is conditioned solely by the presence of dense vegetation, affording at all times adequate shade and the gloom favourable to an insect of crepuscular habits. Its presence on the Lingadzi estate where indigenous trees are practically absent, and where these conditions are obtained through closely planted and untrimmed evergreen citrus and other fruit trees, would seem to indicate that its presence is not influenced by any special kind of vegetation.

When endeavouring to discover the breeding grounds of this fly, my attention was at first naturally concentrated on places similar to those utilised by *morsitans*, and in some of these, under the shelter of fallen dead trees, I found pupa-cases

both of *morsitans* and of *brevipalpis*, never more than three or four of each. But on removing the low, thickly growing vegetation at a spot well sheltered by the foliage of the large trees, I obtained in the course of a two days' search over an area about twenty-five yards square no less than 507 pupa-cases and seven living pupae. This spot differed in regard to soil and vegetation in nowise, so far as I could ascertain, from the rest of the neighbourhood, but it was traversed by a path along which game is evidently in the habit of passing to and from the water, and moreover it is close to the edge of a sandy bank (the original edge of the lake, which is gradually receding), and I imagine it to be probable that beasts may loiter there as a measure of caution before descending into more open country, as a result of which replete female flies, incapable of prolonged flight, would shelter there. More pupae have been found in similar situations, 109 pupa-cases in one place, and 4 pupae and 54 cases in another. I expect that the small number of living pupae hitherto found may be explained by the breeding season being over. As with the pupae of *morsitans* there is some variation in regard to size.

Some of the flies have emerged from the pupae ; all, as was to be expected, in the late afternoon ; one, a female, attempting to do so tail end first, a condition not unfrequently seen also with *morsitans*.

Small round holes, indicating probably the escape of larger Chalcids, were seen in four pupa-cases only out of a total of 737. No other evidence of parasitism was obtained by an examination of the cases, but on placing one of the pupae in a jar containing a female *Mutilla glossinae* with *morsitans* pupae, the Mutillid unhesitatingly bored a hole in the usual way and oviposited in it.

Fig. 1. Haunts of *Glossina morsitans*; flat country covered with short grass and clumps of Borassus palms and low shrubs.

Fig. 2. Haunts of *Glossina morsitans*; flat country covered with very tall grass and clumps of large shade trees.

Fig. 1. Haunts of *Glossina morsitans;* higher rocky ground covered with short grass and stunted bush.

Fig. 2. A breeding place of *Glossina morsitans;* at the point indicated by the piece of paper 7 living puparia and 4 empty cases were found.

Fig. 1. A breeding place of *Glossina morsitans*; in the four spots indicated by slips of paper 14 fresh and 15 old puparia were found ; the stones were situated among high grass.

Fig. 2. Under a dead tree in the bushes to the left 11 fresh and 79 old puparia of *Glossina morsitans* were found.

A BLOOD-SUCKING SPECIES OF PERICOMA IN QUEENSLAND (DIPT.).

By Frank H. Taylor, F.E.S.,

The Australian Institute of Tropical Medicine.

(Plate VII.)

Hitherto no flies of the family Psychodidae have been recorded from Australia. However, during the year 1913 three specimens of a single species were taken in Townsville, one of which was subsequently submitted to Mr. E. E. Austen, who informed the author that it belonged to the genus *Pericoma* and was probably a new species. As I have been unable to determine it as one of Brunetti's Oriental species, I now describe it as new.

I wish to acknowledge with gratitude Mr. Austen's generous assistance to me on this and many other occasions.

Pericoma townsvillensis, sp. n.

Head densely clothed with brown hairs with white apices; antennae pale, with white verticillate hairs, the base and second segment clothed with pale scales; palpi densely clothed with black scales. *Thorax* clothed with light brown hairs with white tips. *Abdomen* with very dense brown hairs with snow-white tips; venter clothed with dark brown hairs. *Legs* pale, covered with dark scales; the apex of the first tarsals white, all remaining tarsi white; the femora, tibiae and first tarsals with dark hairs and bristles, which are particularly prominent on the first tarsals and hind tibiae. *Wings* densely clothed with dusky hairs; fringe dusky and very prominent; veins pale, their apices and the forks of the second and fourth veins with very distinct black, scaly hair-spots.

Length, 1·7 mm.

Queensland: Townsville (*Dr. H. Priestley* and *F. H. Taylor*).

Described from two specimens (a third in the British Museum), which were captured indoors during May. This species is a very severe biter, the irritation remaining for some hours. In one case the swelling raised by the bite was surrounded by a marked reddish areola, both of which persisted for three weeks.

Type and one other specimen in the collection of the Institute.

Wing of *Pericoma townsvillensis*, Taylor, sp.n.

A NEW THRIPS DAMAGING COFFEE IN BRITISH EAST AFRICA.

By C. B. Williams, B.A., F.E.S.,

The John Innes Horticultural Institution, Merton, Surrey.

The Thrips described below was submitted to me by Mr. Guy A. K. Marshall, Director of the Imperial Bureau of Entomology, to whom it had been sent by Mr. T. J. Anderson, the Government Entomologist in British East Africa.

Fam. THRIPIDAE.

Diarthrothrips, gen. nov.

General form rather slender. Chitin unreticulated. Antennae eight-segmented, stylus shorter than the sixth segment. Head about as long as broad. Ocelli rather far back on the head. Maxillary palps two-segmented ; labial palps one-segmented (possibly a second short basal one indistinctly separated from the labium). Mouth-cone somewhat long and bent downwards away from the prosternum. Thorax and abdomen slender. Two long spines on the hind angles of the prothorax, none at the fore angles. Wings slender, the greater part of the fore vein without spines. The ninth segment of the male without stout dorsal spines.

Type species, *D. coffeae*, nov.

This genus, on account of its two-segmented maxillary palps, bears a somewhat similar relation to *Physothrips* to that which *Baliothrips* does to *Thrips*. It is, however, further separated from *Physothrips* by the more slender build and the longer mouth-cone. The presence of ring joints at the bases of the fourth and fifth antennal segments, as mentioned below in the specific description, somewhat recalls *Cricothrips*, Trybom, from Zululand, but this character is found in species of other genera (e.g. *Physothrips antennatus*, Bagnall) and varies in distinctness in individuals. In the present species it seems to be more of the nature of a stage in the development of the pigment of the segment, and in darker specimens the light separation is often indistinct, particularly in the fifth segment ; it is, however, always visible. On these grounds I do not consider it of generic value. From *Cricothrips* it is also distinguished by the absence of the dorsally swollen front part of the head and by the two-segmented maxillary palps.

Diarthrothrips coffeae, sp. nov. (fig. 1).

Female.

Measurements.—Head, length 0·130 mm., width 0·130 mm. ; prothorax, length 0·108 mm., width 0·160 mm. ; pterothorax, length 0·260 mm., width 0·206 mm. ; abdomen, width about 0·20 mm. ; wing, length 0·75 mm., width (about middle) 0·034 mm.

Antennae		1	2	3	4	5	6	7	8
length (μ)	..	26	36	50	56	41	50	9	18
width (μ)	..	29	24	18	18	16	17	8	6

Total body length about 1·16 mm., antennae 0·30 mm.

Colour pale yellowish brown, the sides of the head posteriorly and the abdomen, except for the last three segments, a little darker. Wings pale yellowish with two small dark areas. Pigment round the ocelli red. Antennae rather darker than the body; legs lighter.

Head (fig. 1 *a*) about as long as wide; sides of the head not arched, more or less parallel. *Eyes* large, but not projecting. Distance between the eyes about one and a quarter times the width of the eye; distance from the eye to the back of the head about equal to the length of the eye. *Ocelli* far back on the head, the posterior pair

Fig. 1. ***Diarthrothrips coffeae***, **Williams, sp. n.; *a*, head and prothorax; *b*, maxillary palp; *c*, antenna; *d*, forewing; *e*, antenna of larva; *f*, antenna of Aeolothripid larva.**

on a level with the hind margin of the eyes; the three forming an equilateral triangle. A pair of long slender ocellar spines on the sides of the triangle rather nearer the anterior ocellus, a shorter pair more anterior (one near the margin of each eye), and two quite short ones near the median line on the frons. There is also a row of about six short slender spines across the head behind the eyes. The hind part of the head is faintly striated. *Mouth-cone* rather long and bent downwards; when, in mounted specimens, it is pressed against the prosternum it reaches to the hind margin of it. *Maxillary palps* (fig. 1 *b*) two-segmented, the apical segment the longer. *Labial*

palps apparently one-segmented, but with sometimes a doubtful second short basal segment indistinctly separated from the labium. *Antennae* (fig. 1 *c*) eight-segmented, rather long and slender, more than twice the length of the head : The first segment short and broad, very slightly tapering to the apex ; the second longer and narrower, barrel-shaped ; the third longer than the second, with a distinct pedicel at the base and tapering to a short neck at the apex ; the fourth longer than the third, and with the apical neck longer ; the fifth shorter than the third and without the constricted apex ; the sixth slightly shorter than the fourth ; the eighth longer than the seventh, the two together being about half as long as the sixth ; forked trichomes on the third segment dorsally and on the fourth ventrally, the latter the longer. Colour : the first, second, sixth, seventh and eighth uniformly brown, a little darker than the body, the third and fourth brown except at the apex, the fifth paler at the base. Near the base of the fourth and fifth segments is a clear ring which separates off a narrow darker ring at the base ; this varies in distinctness in individual specimens (see above).

Prothorax almost as long as and only about one-quarter wider than the head, with the sides nearly parallel. Two long slender spines at each hind angle, shorter ones on the fore and hind margins and a number of still shorter weak spines scattered over the pronotum. *Pterothorax* rather slender, angles rounded in front. *Legs* long and slender, paler than the body, the femora darkened in the middle. Fore femora not swollen ; tarsi unarmed. *Wings* long and slender. Two longitudinal veins present in the front wing (fig. 1 *d*), the hind vein arising from the fore vein about one-quarter of the wing length from the base. On the costa 24–27 spines ; on the fore vein 3 at the base, 2 at the level of the origin of the hind vein and 2 near the apex ; on the hind vein 14–16. The anterior marginal fringe commences just distal to the fork of the veins ; the posterior fringe at its greatest length is about seven and a half times the width of the wing. Colour pale yellowish, with an indistinct dark area at the level of the origin of the hind vein and a second, more distinct in the posterior half of the wing, about half way between the first and the apex. Spines on the wing pale, except those arising in the dark areas which are darker. Hind wings clear, with a single vein only distinct in the basal half of the wing. *Abdomen* slender, tenth segment short, only about two-thirds the length of the ninth, spines at the apex pale and slender, those on the ninth and tenth segments being about equal in length.

Male.

Paler than the female and about one-fifth smaller. In the antennae the first two segments are clear, also the bases and apices of segments 3 and 4 and the base of 5 ; 6–8 are uniformly brown, but not so dark as in the female. On the costa of the fore wing are usually 22–24 spines, on the fore vein as in the female, and 12–14 on the hind vein : one male, however, has only 20 on the costa and 7 on the hind vein of one wing and 21 and 9 respectively on the other wing. There is no indication of clear areas on the abdominal sternites and there are no stout dorsal spines on the ninth tergite.

Measurements.—Head, length 0·100 mm., width 0·102 mm. ; prothorax, length 0·080 mm., width 0·130 mm. ; pterothorax, length 0·20 mm., width 0·164 mm. Total body length 0·97 mm., antennae 0·240 mm.

Described from numerous females and nine males collected on coffee at Kabete, British East Africa, in May 1915 by Mr. T. J. Anderson.

Type in the British Museum.

In the tube with the adults were also a large number of larvae and two prepupae. From the occurrence of the latter it would appear that the pupal stages are passed on the leaves with the larvae, but no doubt notes on the biology will be forthcoming from Mr. Anderson.

The *larvae* (described from specimens preserved in alcohol) are pale yellowish in colour with the small eyes and the tip of the mouth-cone dark. There are the usual spines on the ninth and tenth abdominal segments, but no characteristic processes such as are found in some species. The length of the fully-grown larva is 1·1 mm. The antennae (fig. 1 *e*) are six-segmented and comparatively short (0·16 mm.). The head is a little longer than broad.

The *prepupa* is also pale yellowish in colour, about 1·0 mm. in length and with the wing rudiments reaching to the second abdominal segment.

Amongst the larvae of *D. coffeae* was a single larva of some species of thrips of the family AEOLOTHRIPIDAE. The known larvae of this family are largely, if not entirely, predaceous and frequently feed on other thrips and their larvae; it is therefore quite probable that this one was feeding on the larvae or adults of the coffee thrips. It is similar in colour to the latter (pale yellow), but can easily be separated from this by the larger size (1·4 mm.), the shorter head, which is much broader than long, the longer legs and antennae, and its more active habits. The antenna is figured (fig. 1 *f*) for comparison with that of *D. coffeae*, at the same magnification. In the present state of our knowledge of the group it is not possible to say definitely to which genus it belongs.

Among about forty specimens of *D. coffeae* examined there are two with abnormal antennae. In the first, a female, the left antenna consists of only five segments, segments 1–4 being normal, while the fifth resembles the fused 6th, 7th and 8th of the normal antenna; the normal 5th segment seems to have disappeared entirely; the right antenna is quite normal. In the second, a male, the right antenna consists of seven segments, the reduction in this case being caused by the fusion of the 5th and 6th to form one long one; the last two segments are normal as also is the left antenna.

[Mr. Anderson states that this thrips has done serious damage to the leaves of coffee in several districts of British East Africa.—ED.]

A BUTTERFLY INJURIOUS TO COCONUT PALMS IN BRITISH GUIANA.

By Laurence D. Cleare, Jr., F.E.S.,

Biological Division, Department of Science and Agriculture, British Guiana.

(Plates VIII–X.)

During the past year (1914) the coconut palms in the city of Georgetown have been rather severely attacked by the larvae of the Coconut Butterfly, *Brassolis sophorae*, L.

While this pest has apparently been known in the Colony for some time, it received but little attention until about five years ago, when it made its appearance in the Mahaicony district in very large numbers, causing considerable damage. Mr. F. A. Stockdale, then Assistant Director of Agriculture, investigated the attack and reported upon it.

From that time until the early part of last year *Brassolis* was known to most people only by name. In a few months, however, it forced itself upon the attention of the inhabitants, and by June of the same year the result of its ravages was perhaps the most noticeable feature in Georgetown.

It was then decided that a census of the coconut palms in the town should be taken and a plan showing the affected areas prepared. The task of preparing this census and plan fell to the writer and it is here proposed to give some description of the work together with notes on the pest.

When the work was started there existed no Plant Protection Ordinance in the Colony, though such an ordinance came into force shortly afterwards.

Owing to the area of this city of some 60,000 inhabitants, it was decided that it would be impossible to enter all the premises, as this would take some months, and neither would the pest remain, nor would the time at our disposal allow of it. Nor was it necessary, for the palms were usually of such a height that they could, in most cases, be easily seen from the street. On account of the small size of the plan, each affected tree could not be marked, so if but a single palm was attacked in a block the entire block was marked as an affected area. The plan (Pl. viii) was made in June 1914, when the attack was probably at its worst.

History.

The first appearance of *Brassolis sophorae* as a pest in this Colony probably dates many years back. Schomburgk in his " Fauna und Flora von British Guiana " (1848) records it as being found on the coast-lands but gives no food-plant. Within recent years it has been reported in 1905 from Plantation Grove, near Clonbrook, " when large areas of coconuts were considerably damaged," and it was in September of that year that Mr. A. W. Bartlett, then Government Botanist, bred the adult insect and reported upon it. His report was published in the Official Gazette of 28th October 1905.

The next appearance of this pest seems to have been in 1909, in the Mahaicony district, when Mr. Stockdale reported upon it. His report was published in the Official Gazette of 28th July 1909, and an article entitled " A Caterpillar Pest of

Coconuts" by the same author appeared in The Journal of the Board of Agriculture, British Guiana, for July 1909. On both of these occasions the palms in Georgetown were attacked.

Between 1909 and the present attack *Brassolis* was of little importance; in fact, it was seldom seen. It would thus appear that this insect occurs in such numbers as to cause considerable damage at intervals of about five years.

Food-plants.

The attacks of this pest are not confined to the coconut palm. The common Cabbage Palm (*Oreodoxa oleracea*) is also attacked, and while these palms do not seem to die so easily, they rarely recover in a satisfactory manner if badly stripped.

Distribution.

Little is known of the distribution of the coconut butterfly in British Guiana. It has been reported, as previously mentioned, from Plantation Grove near Clonbrook, the Mahaicony district, and Georgetown, in the county of Demerara; and from Onderneeming, on the Essequibo Coast. Mr. Bartlett, in 1905, said that the palms in Berbice were also attacked, but remarked that the pest does not seem to occur in the county of Essequibo. It is probable that *Brassolis* is found along the entire coast-lands.

Outside of the Colony, *Brassolis* was recorded from Dutch Guiana by Mme. Merian as early as 1705 in her "Metamorphosis Insectorum Surinamensium," and while she gives *Müllera moniliformis*, L., as the food-plant, adds, "Later on I found a very large number on a high coconut tree; . . . . on this tree these caterpillars had made or rather had spun a bag." Thus, although she did not recognise the correct food-plant, she gives a description of the characteristic "nests" of the larvae. It is possible then that *Brassolis* occurred in this Colony at the same date.

From the Island of Trinidad Kaye records it in his "Additions and Corrections to my Catalogue of *Lepidoptera Rhopalocera* of Trinidad (1904)" * as being taken in 1906, and gives the range as Guiana to South Brazil, while Mr. J. H. Hart, in the "Bulletin of Miscellaneous Information, Trinidad," records its attack on the cabbage palm in 1908.

Life-history and Habits.

The *eggs* are laid in masses of 100–150 on the stem and underside of the leaves of the coconut and other palms (Pl. x, fig. 2). They are smooth and shiny, pinkish in colour, and cylindrical in shape. There is a small circular depression about the centre of the top, which is also slightly reticulated, the lines running from the central spot. These reticulations are more marked round the edges and tend to disappear towards the central spot. The egg measures about 1 mm. in diameter. The embryos become visible as development proceeds, giving the apices a slate colour a short time before the emergence of the young larvae.

The *larvae* in most cases emerge from a mass simultaneously. They then eat off the top half of the eggs, leaving only the lower parts adhering to the leaf.

* Trans. Ent. Soc. London, 1913, p. 547 (1914).

Newly hatched larvae measure about 4 mm. in length and are about ·3 mm. broad. The head is large and out of proportion, being about ·7 mm. in breadth ; black to dark reddish-brown, shining, and clothed sparsely with a few short light-coloured hairs. The body is a light claret-red in colour, with six light yellow longitudinal stripes extending its entire length ; these are equidistant, four being lateral ; the two dorsal are slightly better defined than the lateral ones. The whole body is clothed sparsely with fine longish hairs, each arising from a small tubercle, of which there are about eight to each segment. The anal segment is chitinous. The ventral surface is slightly lighter in colour than the dorsal.

From the beginning they show the habits of the adults in crawling in procession or resting with their heads all pointing in one direction. After the first 24 hours (during which time they refuse to feed) they commence eating the green parts of the leaves with great voracity. They rapidly increase in size and become darker.

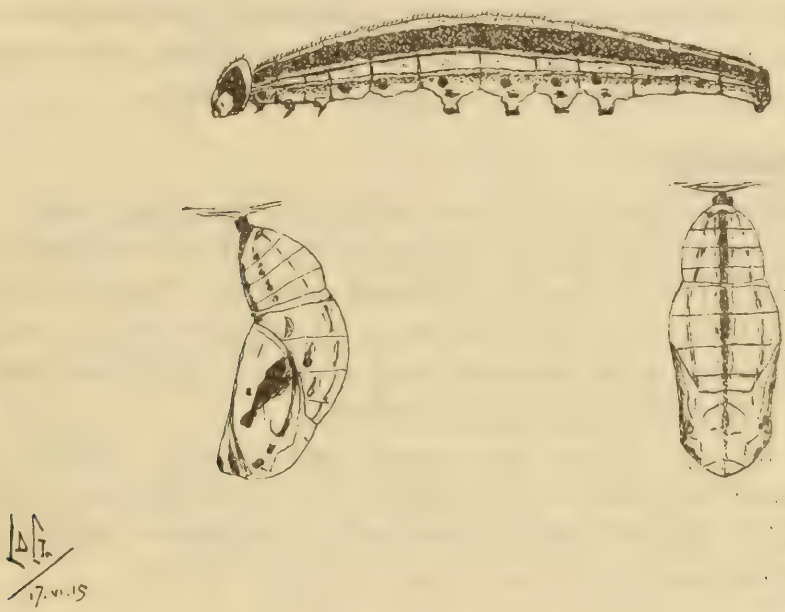


Fig. 1. *Brassolis sophorae*, L. ; larva, and lateral and dorsal view of pupa.

When full grown the larvae measure about 50 mm. (fig. 1). The head is of a reddish brown colour and bears two spots of a very dark brown, which sometimes cover the greater part of the anterior portion ; it is clothed with short, soft, light-coloured hairs. The body is of a dark brown colour, with longitudinal lines of a pale dirty yellow extending along its length. Nine lines can be distinctly seen immediately behind the head, three situated dorsally and six laterally, but become less distinct as they extend backwards. This is particularly so with the dorsal ones, which become fused after about the fourth segment, forming a broad band. In the lateral lines the middle ones become considerably broadened, but do not fuse with the others. On the first segment there is a dark spiracle, also one on each segment from the fourth to the eleventh. There are a few scattered spots on the surface between the dorsal and lateral lines. The entire body is covered with short, soft, light-coloured hairs.

The habits of the larvae are rather peculiar. They feed almost exclusively at night, resting during the day in long cylindrical pockets open at both ends and formed by binding together with silken threads a number of leaflets of the palm. In these "nests" several hundred larvae collect with their heads all pointing in the same direction, and a single nest may weigh as much as two pounds. These nests may be seen on nearly every tree attacked and are frequently the only green parts of the leaves that remain. When the larvae move from place to place they do so in procession. The duration of the larval stage is not accurately known, but it is estimated to be about four weeks.

The *pupae* (fig. 1) are of two sizes, the female being larger than the male and averaging about 25 mm. in length. The ground-colour is at first green, but soon becomes a pinkish brown. Five irregular brown lines, bordered on either side with white, extend the whole length of the body along the back and sides. Three of these are dorsal, of which the mid-dorsal is the broadest and best defined. There are two additional brown lines on the underside of the abdominal part and two diagonal brown patches on the wing cases. The thorax is separated from the abdomen by a ring devoid of markings. The pupal period lasts about 14 days.

Description of the Butterfly.*

Male.—The *upperside* of the wings is as follows:—Fore wings brown, with an orange-yellow bar across the centre; hind wings brown, suffused with reddish, which is tinged with orange. Thorax brown, abdomen reddish. The *underside* lighter brown, speckled with white; one eye-like mark on each fore wing, and three on each hind wing. The wings of the male are more angular in shape and smaller than those of the female. Wing expanse, 2·5–2·75 inches.

Female (Plate x, fig. 1).—Wings more ample and rounded, similar in colour and markings to those of the male, except that the bar across the fore wings is duller yellow and somewhat Y-shaped, and the hind wings are deeper brown with small reddish patches near the margin. Wing expanse, about 3 inches.

Spread of the Pest.

A rather noticeable thing about this attack was the manner in which the pest spread. While the exact place of origin is not known, observations point to La Penitence, south-west of the town, or some spot in its vicinity. The attack then spread from south-west to north-east in direct opposition to the prevailing winds. The insects never crossed the river, in spite of the wind being in their favour. This, however, was probably due to their feeble powers of flight, thus Kitty village, north-east of the town, remained untouched throughout the whole period, whilst Albert town, separated from it by but a few empty blocks, was by far the worst affected ward in the city.

Although practically the whole city suffered, there were blocks in the midst of affected areas that remained untouched. It was particularly noticeable that the palms near the sea were but very slightly, if at all, attacked. In fact, not a single tree of the entire avenue extending along the sea-wall suffered from the pest. It is

* Guppy, P. L. Circular No. 5. Bd. of Agriculture, Trinidad and Tobago, pp. 19–21. pt. 1.

probable that the force of the wind had much to do with their escape, although solitary instances are on record of the butterflies having been observed in this vicinity.

Amount of Damage Done.

Palms that have been attacked are "skeletonized." The caterpillars devour all the green part of the leaves, leaving only the thick central midrib and the fine lateral veins (Pl. ix). They pass in this manner from leaf to leaf until the entire tree becomes denuded. The attack may be so severe that the tree succumbs, this having occurred in a large number of cases in Georgetown.

In September, after the insects disappeared (for they went away as mysteriously as they came), a count was made of the palms that had died from this attack of *Brassolis*. In the whole town there were about 107 dead palms. It was estimated that there were some 2,000 of these palms in the city, so that about 5 per cent. had succumbed to the attack.

We can get some idea of the financial loss caused through this insect by making some simple calculations. The average age at which a tree begins to bear is about five years, so we can replace any tree in that time, and taking the average return at \$1 (4*s*. 2*d*.) per tree per annum, this being the figure generally used, the loss on 107 trees is \$535. To this we must add the loss from nineteen hundred trees for eighteen months, the period taken by them to recover. At the same rate this would amount to \$2,850.00, making a total of \$3,385.00 (£705 4*s*. 2*d*.). This estimate is for the city of Georgetown alone; should the loss in the coconut districts, Mahaicony, etc., be taken at the same figure, the amount would probably be startling.

Writing of the attack at Plantation Grove in 1905, Mr. Bartlett says, "The greater number of the trees in the cultivation of 40 acres have had every portion of the green part of their leaves devoured, and present the appearance of brown skeletons of trees." In the same report he goes on to say, "In Georgetown I estimate that quite half of the various kinds of palms scattered about the city, excluding those growing in the Botanic Gardens, where I am glad to say the caterpillars have not appeared, have been more or less injured by this pest, some to such an extent that they have died."

It is noticeable that in this attack too the palms in the Botanic Gardens entirely escaped.

Natural Enemies.

Fortunately this pest has many natural enemies. Many birds, particularly the common Kiskadee (*Pitangus sulphuratus*), feed on the adult insects, while both the eggs and pupae are parasitised. Bartlett mentions having reared an egg-parasite, but does not give the name. During this attack two species of egg-parasites were also reared and are at present being determined by Mr. A. A. Girault, through the U.S. Bureau of Entomology. Recently (Jour. Bd. of Agric. B.G., vii, no. 1, 1913, p. 50) the well-known parasite *Chalcis annulata*, F., has been obtained from the pupa of this insect.

There is little doubt that these natural enemies play a very important part in the control of this species, and it is only when natural conditions are adverse to their development that the pest gains a foothold and causes extensive damage.

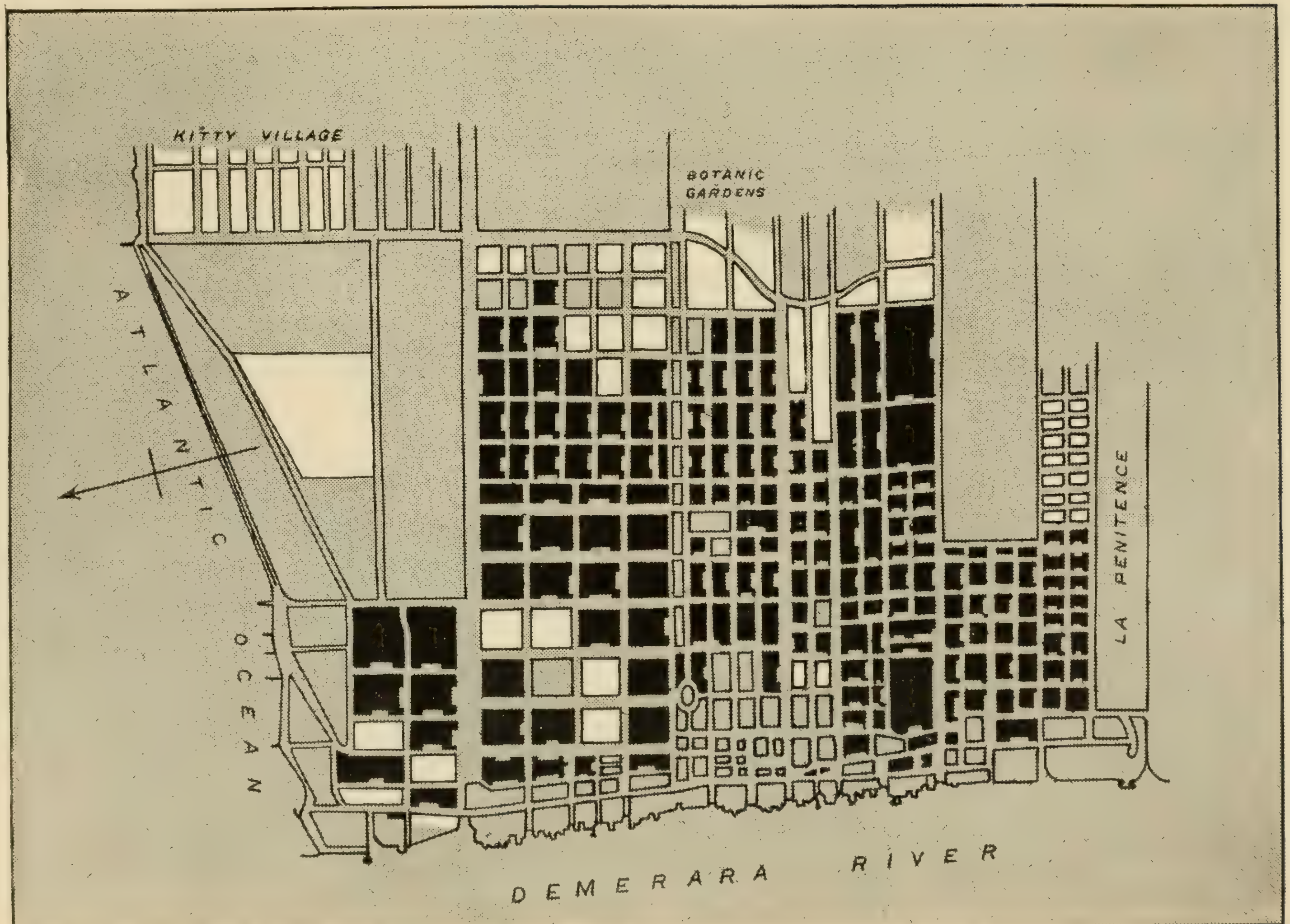
Methods of Control.

The habit of the larvae of living in " nests " during the daytime offers the best means of controlling this pest. The nests can be easily seen from the ground and a boy can be sent up the tree to cut down the branches bearing them. Care should be taken to destroy all the caterpillars in the nests when the branches fall to the ground. This can be done either by immersing them in a pail containing water and kerosene oil, or by simply crushing the nests with a piece of wood or other heavy instrument. When the caterpillars are numerous the work could be carried out by gangs under an intelligent driver.

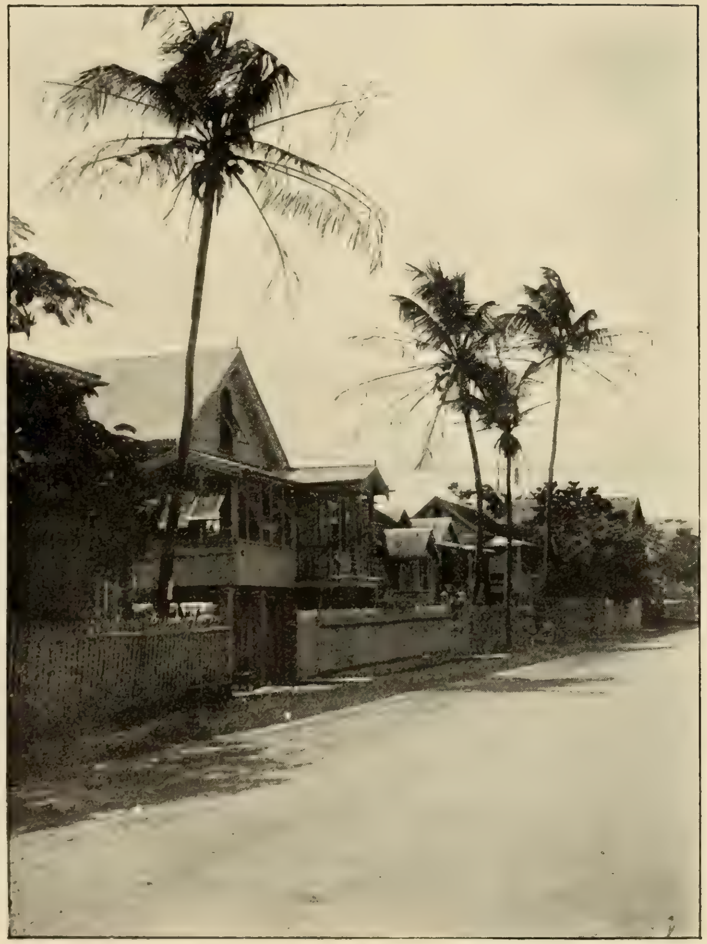
Mr. Stockdale writes, " The labourers might be paid by the number of nests they destroy, and I believe on some estates the price of 2 cents (1*d*.) per nest has been paid for their destruction."

Acknowledgments.

In preparing the paragraphs on the life-history, the reports of Messrs. Bartlett and Stockdale have been largely used, though several points have been added from the notes in the possession of this Division. The description of the butterfly is taken from Mr. Guppy's article as previously acknowledged. For the photographs I am indebted to Mr. G. E. Bodkin, Government Economic Biologist. Although they were taken in January 1915, when the trees were recovering, they give a good idea of the appearance of a tree when attacked.



Plan showing the Distribution of *Brassolis sophorae* in Georgetown, British Guiana,



Views showing the damage done to Coconut Palms in Georgetown by *Brassolis sophorae*.

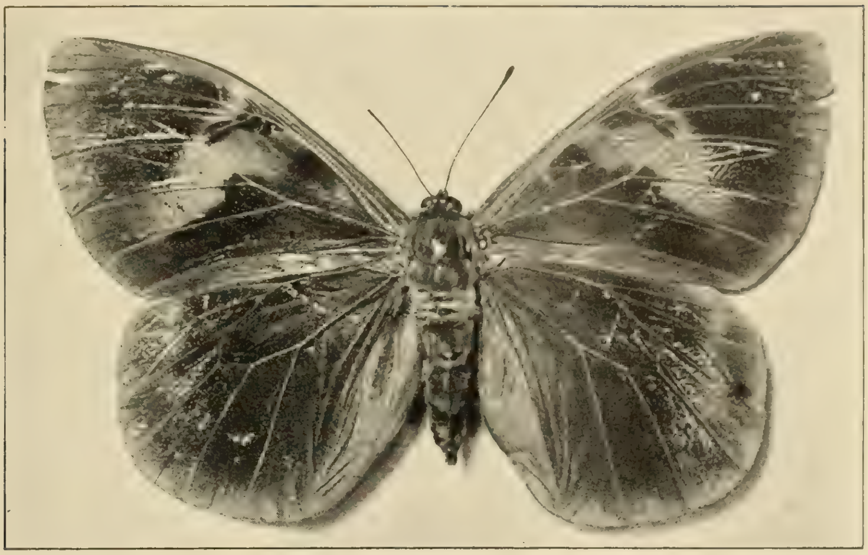


Fig. 1. *Brassolis sophorae*, L., ♀ (slightly enlarged).

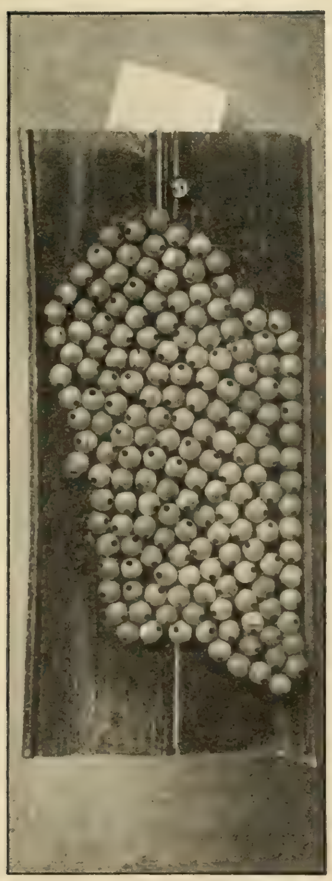


Fig. 2. An Egg-mass of *Brassolis sophorae*.

Fig. 3. Boy climbing a Palm to cut down affected branches.

SOME NEW NEOTROPICAL SIMULIIDAE.

By FREDERICK KNAB,

Bureau of Entomology, U.S. Department of Agriculture.

Dr. Andrew Balfour, Director of the Wellcome Bureau of Scientific Research, has submitted to the writer for study part of the Diptera collected on his recent voyage in the American tropics. A species of *Simulium* from the valley of the Atrato River in Colombia proves to be new and is described below. Through the good offices of Dr. Balfour further interesting material was received from K. S. Wise, Surgeon-General for British Guiana, and from F. W. Urich, Entomologist of Trinidad. These lots contained an additional new species of *Simulium* each, of which the descriptions follow. Diptera belonging to other groups and of economic interest will be treated in subsequent papers.

Simulium sanguineum, sp. nov.

Female.—Occiput, frons and face black, with strong blue and green pearly pruinosity and with scattered short black hairs ; frons broad, above nearly one-third the width of head, narrowing slightly toward antennae. Antennae with the three proximal joints ferruginous, the others dull blackish and with fine, appressed pale pubescence. Scutum velvet black, with four broad, pruinose, strongly iridescent, metallic blue stripes, visible only in certain lights ; outer stripes very broad, leaden gray in some lights, on lateral margins and continued along posterior margin ; submedian stripes broad, nearer to each other than to lateral stripes, slightly sinuate and very slightly narrowed beyond the middle. In some lights the submedian stripes nearly disappear and a pair of similarly coloured wedge-shaped spots appear anteriorly in their place, the base of the wedge on anterior margin, its point terminating at about the middle of the disk ; vestiture of long golden hair-scales, evenly distributed and not arranged in rows or groups. Scutellum narrow, subtriangular, velvet-black, with long golden transverse hair-scales and black bristles on the margin. Postnotum short, black, with pruinosity like that on margins of scutum. Pleurae and coxae black, gray pruinose. Abdomen black, elongate, somewhat constricted beyond base, thickened beyond middle ; first segment dorsally strongly iridescent, the four following ones dull velvet-black and with the flexible basal portion gray ; segments 5 to 8 shining black, highly polished and with a few scattered black bristles. Front legs with the femora luteous and with a brownish shade dorsally ; tibiae luteous, with silvery lustre, the apex very slightly darkened ; tarsi black. Middle legs with the femora and tibiae brownish black, the knees narrowly and the apices of the tibiae yellowish ; tarsi with the first joint whitish except at extreme apex, second joint whitish with dark apical ring, the others wholly dark. Hind legs with the femora brownish black, the tibiae white on basal third, black beyond ; tarsi with the first joint white, black on apical fourth, the second joint white, black on apical third, the last three black. Claws simple. Wings hyaline, without iridescent spot in anal field ; coarse veins pale yellow. Halteres pale yellow, black basally.

Length : Body about 1·2 mm., wing 1·5 mm.

COLUMBIA: Boca de Arquia, Atrato River, v. 1914, attacking man (*Dr. A. Balfour*).

This species is closely related to *S. amazonicum*, Goeldi, and shows very similar thoracic ornamentation. It differs in the absence of the iridescent green-blue bands, present in that species at the apices of some of the abdominal segments. There are also less appreciable differences in the coloration of the legs and in other details.

Simulium limbatum, sp. nov.

Female.—Head blackish, both frons and face with strong metallic blue and pearly lustre; frons broad above and distinctly narrowing toward the antennae. Antennae blunt, the first two joints yellow, the following ones luteous brown, slightly pruinose and with delicate white pubescence. Scutum deep chocolate-brown, with pearly, pale blue ornamentation consisting of broad lateral margins involving the humeri and a narrower posterior margin, as well as two large wedge-shaped spots on the anterior fourth, their blunt ends resting on the anterior margin and their sharp ends continued as narrow lines beyond the middle of the disk; vestiture of rather long silvery hair-scales, rather sparse and not disposed in groups or regular series. Scutellum broad, the hind margins slightly sinuate and converging nearly rectangularly to the apex, dark ferruginous brown, nude on the disk, with coarse black marginal bristles. Postnotum blackish, gray pruinose. Pleurae blackish and uniformly gray pruinose. Abdomen subcylindrical, black, the second, third and fourth segments dull, the others shining, without markings, the apical margins of the segments narrowly pale. Legs slender; coxae and trochanters of all three pairs ochreous, tinged with brown on the hind pair. Front legs with the femora and tibiae ochreous yellow, the former paler apically, the tibiae with silvery white pruinosity on outer side except at base; tarsi wholly brownish black. Middle legs with the femora brown, broadly pale ochreous at apex, the tibiae brown in the middle, both base and apex broadly pale ochreous, their outer sides on the basal half with a white pruinosity terminating obliquely; tarsi with the first joint long and slender, whitish, brown on distal fifth, the second joint broadly white at base, the last three joints wholly brown. Hind legs with the femora and tibiae dark brown, the latter broadly yellowish at base, their outer sides with a white sheen on basal half; tarsi with the first joint slender, compressed, nearly as long as the tibia, white, its ventral margin and the distal fourth blackish, second joint white on the basal half, the last three joints wholly black. All the femora and tibiae with long, recumbent, shining yellowish white hair-scales. Claws simple. Wings broad, the venation normal; thick veins brownish yellow, the costal spines short, stout, dense and black; integument iridescent, more pronounced and predominatingly red on basal half, but not forming a pronounced spot. Halteres white, brownish at base.

Length: Body about 1·3 mm.; wing 1·7 mm.

BRITISH GUIANA: Rupununi River, ix. 1913 (*Dr. K. S. Wise*).

A series preserved in spirits received together with a larger number of *S. amazonicum*, Goeldi.

This species belongs to the same group as *S. amazonicum* and shows its relationship by the close agreement in structural and other details. It differs strikingly in the absence of the pair of thoracic dorsal stripes. The two species were preserved together in the same vials, so evidently occur together.

Simulium placidum, sp. nov.

Female.—Head black, gray pruinose. Frons moderately broad, narrowing gradually but distinctly toward the antennae, with rather numerous, irregularly disposed hairs, except on the disk. Antennae bluntly pointed, the first two joints dull ferruginous, the others darker, finely hairy and pruinose. Scutum dull black, very faintly gray pruinose on the disk, diffuse whitish pruinose toward anterior margin and on the humeri, without distinct markings ; vestiture of pale golden hair-like scales disposed in small, closely approximated groups which do not form regular rows. Scutellum short and blunt, black, with transverse golden scales on the disk and coarse black hairs along the posterior margin. Postnotum short, black. Pleurae dull grayish black, slightly pruinose. Abdomen subcylindrical, black, the basal segment strongly white pruinose, the three succeeding ones velvet-black, the last four shining. Legs black, marked with white as follows : Anterior tibiae with the basal half marked with white on outer side ; middle legs with the tibiae whitish at base and the first tarsal joint white on basal half ; hind legs with the tibiae white at base, the first tarsal joint white on basal half and with the extreme base black, the second joint narrowly white at base. The abundant appressed hairs of the femora and tibiae show a brassy lustre ; front tarsi compressed. Claws with a small sharp tooth in addition to the basal callosity. Wings hyaline, the venation normal ; thick veins dull brown ; anal field with the iridescence moderate and widely diffused, predominatingly green and red.

Length : Body about 3 mm. ; wing 3·5 mm.

TRINIDAD : Arima River, 31.xii.1913 ; females taken in the act of ovipositing (*F. W. Urich*).

In most specimens the anterior coxae, trochanters and femora have a brown cast. This species is closely related to *S. orbitale*, Lutz, and *S. seriatum*, Knab, and shows the same character and disposition of the scales on the mesonotum. As in the latter species, the frons narrows anteriorly and is devoid of scales, but it differs from it in the coloration of the legs and in other details. *S. guianense*, Wise, probably also belongs in this neighbourhood, but the description is insufficient and I have seen no specimens. In supplementary material, sent in alcohol, a male was found which apparently belongs to the present species. It may be described as follows :—

Male.—Holoptic, the eyes with coarse scattered hairs toward median suture, the facets coarse above, very fine below antennae. Antennae black, much more slender than in the female. Mesonotum short and very convex, before scutellum doubly excavate and strongly declivous, velvet-black, the lateral margins and margin of posterior ridge grayish black with leaden lustre, the posterior declivity leaden gray and with a pair of large velvet-black spots. Scutellum very small, tubercular. Pleurae grayish black, faintly pruinose. Front and middle pairs of legs longer and more slender than in the female ; hind legs shorter and more hairy, the tibia and first tarsal joint more strongly incrassate, the latter with basal third only whitish.

This species apparently does not attack man. Mr. Urich has kindly sent me the following notes on the biology of this species :—

Oviposition : The females hover over the stream where the current is strongest and rushing over boulders forms miniature rapids. The object of this hovering is

no doubt to select a suitable place for oviposition. The female *Simulium* approaches the current quite near and selects a spot on a boulder or stone at the side of the big current, but just covered by a thin film of water. She settles and holding on with her claws she lays as fast as she can, sticking her eggs to the stones in little groups of 6 to 20. It happens that sometimes she is swept away by the current, but this does not seem to disconcert her in the least, as immediately afterwards she may be seen hovering over the same place. As many as five females were observed hovering over the same place at a time. Females caught in these places and put into tubes continued ovipositing, sticking their eggs to the glass very easily.

Incubation of egg : Eggs laid in a glass tube hatched after five days.

Habits of larvae : The larvae are found in the strongest current, attached to almost vertical walls of boulders ; sometimes they are found on sticks or leaves in the strong current.

Pupae : Found in same places as larvae.

Habits of adults : Considering the number of larvae seen in the stream, there are comparatively few adults about. The writer has never been attacked by them. All that were taken feeding occurred inside the ears of horses or mules.

Note.—The " type " and paratype specimens have been returned by Mr. Knab to the collections of the Wellcome Bureau of Scientific Research, London. Other paratypes are held in the collections of the U.S. National Museum, Washington, D.C.—M. E. MacGregor.

LA LIMITE OCCIDENTALE DE LA GLOSSINA MORSITANS DANS LE KATANGA DU NORD.

Par le Docteur Schwetz.

(Carte I.)

Je n'aurais pas voulu répéter ici ce que j'avais déjà écrit concernant la *G. morsitans* dans mes rapports précédents, mais, d'autre part, les renseignements que j'y avais donnés sont nécessaires à la clarté et à la compréhension de ce que je vais dire ici.

Je transcris par conséquent ici quelques pages d'un de mes rapports précédents ("Un voyage en zig-zag dans le district du Lomami," Novembre 1913). On verra alors que le petit article actuel n'est que la suite et la conclusion de ce que j'avais dit précédemment.

"Trois facteurs principaux dominent la distribution des glossines dans une région. Ce sont (1) le climat, c'est à dire la latitude, l'altitude et en partie la longitude ; (2) la végétation (forêt, parc, 'brousse' (?), savane, steppe) ; et (3) la distribution de l'eau (lacs, rivières, ruisseaux, marais). De la combinaison variable de ces facteurs dépend non seulement la présence ou l'absence des glossines en général, mais aussi la présence ou l'absence de telle ou autre espèce (ou du moins groupe principal) des glossines. Connaissant par conséquent, les trois facteurs en question d'une région centre-Africaine, on peut déjà à priori prévoir et prédire la présence, ou l'absence de tel ou autre groupe des glossines.

Le district du Lomami occupe la région située entre le 5° et le 9° P.S. et entre les 23° et 25° Long. C'est donc un pays tropical, avec deux saisons plus ou moins marquées suivant la latitude. L'altitude varie entre 1,100 mètres environ, dans le sud, et 500 mètres environ, dans le nord.

Si administrativement le district du Lomami appartient au Katanga, il s'en distingue au double point de vue géologique et botanique. Je ne m'arrêterai pas sur les différences géologiques (absence de mines notamment) qui ne m'intéresse pas ici, mais je rappellerai que, au point de vue végétation, le Katanga est caractérisé par un 'parc' ('brousse du Katanga') presque continu, interrompu seulement par des plaines herbeuses (savane ou steppe) sur des plateaux très élevés. Or, ce n'est que le bord sud-est du district du Lomami qui présente le parc du Katanga ; tout le reste du district est occupé par une savane plus ou moins typique et entrecoupée par-ci par-là par des bandes (le long des rivières) et par des étendues plus ou moins grandes (dans les bas fonds) de vraie forêt équatoriale. Dans certaines régions (par exemple entre Mutombo Mukulu et Kabongo) on rencontre, il est vrai, des endroits rappelant le parc, mais ces endroits sont isolés et ne forment pas de grandes étendues continues comme le vrai parc du Katanga.

Je dois dire à ce propos, que la terminologie de 'brousse, savane,' etc., est très embrouillée, et donne par conséquent souvent lieu à une confusion. Chaque auteur en interprête à sa façon. Dans certains livres et brochures les explications des termes 'brousse' et 'savane boisée' sont si vagues qu'on n'y comprend plus rien du tout.

Cela s'explique par le fait que la nature est infinie dans ses variations et se prête très difficilement à nos définitions schématiques, à nos rubriques. Les schémas sont cependant utiles en facilitant la compréhension des phénomènes compliqués et en systématisant ainsi nos idées. Je vais par conséquent dire ce que je comprends, moi, sous les différentes formes de la végétation tropico-équatoriale. Et je dirai d'abord que le mot ' brousse ' ne définit en somme rien du tout. Brousse veut dire en langage africain : en route, hors du poste. C'est donc un terme générique et même négatif (par opposition au ' poste,' chez soi).

(1) Je n'ai pas besoin de donner la définition de la *foret équatoriale.* On sait que c'est une réunion de très hauts arbres dont les branches supérieures donnent une ombre continue et permanente et dont les troncs sont entourés et entreliés de buissons, arbustes, lianes et plantes grimpantes, formant un tout inextricable et infranchissable. Dans les régions à savane (je parle du Lomami) on rencontre la forêt le long des rivières (galeries boisées le long des cours d'eau) et dans des bas-fonds marécageux.

(2) On appelle *parc* (ou *bois*) une étendue, couverte d'arbres plus ou moins rabougris en général, donnant peu d'ombre. Pas ou presque pas de lianes ni de plantes grimpantes. On peut marcher facilement entre les arbres.

(3) On appelle *savane* une étendue plate ou ondulée, couverte d'herbe. Quand cette dernière est courte, on a alors un *steppe.* La savane est rarement uniquement herbeuse. Ordinairement on voit par-ci, par-là des bouquets de buissons, d'arbustes et d'arbrisseaux. Quand ces bouquets sont nombreux et les arbustes et arbrisseaux assez hauts, on a alors la *savane boisée* (ou brousse). La savane boisée est donc une transition entre la savane simple et le parc.

Je rappellerai à présent que toutes les glossines ont besoin de l'ombre. Mais tandis que la *morsitans* a besoin d'une certaine fraicheur et se passe du voisinage immédiat de l'eau, la *palpalis* exige une température ' lourde,' modérément chaude et humide, et le voisinage immédiat de l'eau sous n'importe quelle forme—lacs, rivières, marais, et même, à la rigueur, marigots.

En d'autres termes, le *morsitans habite exclusivement le parc.* La *palpalis* habite exclusivement le *voisinage immédiat de l'eau entourée* (ou même ' couverte ' : marais) d'une *végétation touffue.* C'est à dire que dans toute l'étendue de la vraie forêt équatoriale (que je connais très peu) la *palpalis* peut se trouver partout où il y a de l'eau, tandis que dans les régions à savane la *palpalis* peut exister dans les galeries boisées des cours d'eau et dans les bas-fonds boisés. *La savane elle même est toujours exempte de glossines* ; pas de *morsitans* dans les plaines ni sur les plateaux ; pas de *palpalis* dans le voisinage de l'eau quand celle-ci est bordée d'herbes ou de roseaux, ou de papyrus, mais sans arbres, ce qui se rencontre parfois, il est vrai, bien rarement.

Ceci dit, il me suffira d'ajouter, pour la compréhension préliminaire de la distribution générale des glossines dans le district du Lomami, que toute la région est sillonnée de milliers de cours d'eau boisés et couverte de nombreux lacs-lagunes, marais et marigots assez souvent également boisés.

J'ai dit plus haut que le bord sud-est du district du Lomami est couvert d'un parc, terminaison de celui de tout le Katanga et de toute la Rhodésie du Nord.

J'ai traversé ce bord (ou plutôt bande terminale) depuis Kikondja jusqu'à Kabongo. Dans les environs de ce dernier poste le parc disparait insensiblement, c'est à dire se transforme peu à peu en savane boisée et savane simple.

Eh bien, j'ai vu la *morsitans* le long de presque toute la route de Kikondja à Kabongo. Rare dans les environs des villages Kakongolo et Matabongo, la *morsitans* existe en assez grand nombre entre Kasakaï et Kakolowa. Abstraction faite de la grande rivière Lovoï, où existe la *palpalis*, je n'ai vu que la *morsitans* entre Kikondja et Kabongo, même sur les quelques petites rivières que j'ai traversées.

Pouvais-je prévoir, ne connaissant pas encore le Lomami, ce qui m'est arrivé ? Pouvais-je croire, le jour de mon arrivé à Kabongo, que je ne reverrais plus la *morsitans*, la ' vulgaire ' *morsitans*, qui infeste tout le sud-est de l'Afrique centrale, et qui, affamée, s'accrochait par sa trompe, même à la pulpe de mes doigts, entre Kambove et Bukama ? Et pourtant c'est comme cela. Depuis lors j'ai voyagé des mois et des mois à travers le district du Lomami, plusieurs milliers de glossines ont passé depuis lors entre mes mains, mais je n'ai plus jamais revu la *morsitans*.

Je sais cependant où je pourrai la retrouver. Il me suffira pour cela d'aller rejoindre le bord est ou le bord sud de ma ' brousse du Katanga,' c'est à dire aller de Mutombo Mukulu à Bukama, de Kisengwa à Ankoro-Buli, de Kabongo à Ankoro, en un mot vers le Lualaba. C'est ce que je vais faire. Je pourrai alors déterminer encore plusieurs points de la limite extrême-nord et ouest de la grande zone à *morsitans*. Il est hors de doute que cette limite coïncidera plus ou moins partout avec celle de la vaste étendue du grand parc Katangalais.

Je ne manquerai pas, bien entendu, de faire connaître le résultat de mes observations."

Les voyages projetés par moi l'an passé, de Mutombo Mukulu à Bukama, de Kisengwa à Ankoro, etc., sont à présent un fait accompli, et je puis maintenant " tenir parole " de ne pas manquer de faire connaître le résultat de mes observations. Et je m'empresse de dire que mes prévisions, ou mon hypothèse, que la limite nord-ouest de la grande zone à *morsitans* coïncide plus ou moins partout avec celle de la vaste étendue du grand parc Katangalais, ont parfaitement été confirmées par quatre contrôles différents.

Mon dernier long voyage sera prochainement décrit en détail dans un rapport spécial ; ici je ne donnerai que quelques renseignements sommaires sur les limites respectives de la *morsitans* et de la végétation dominante.

(1) *De Kasongo Niembo à Bukama.**

Jusqu'à la rivière Lovoï savane exclusivement herbeuse. Depuis la Lovoï jusqu'à Kamasi-Songe végétation transitoire : plaines herbeuses entrecoupées de savane boisée et même de parc. Depuis Kamasi-Songe jusqu'au Lualaba (Bukama) parc typique et ininterrompu.

Pas de *morsitans* avant Kamasi-Songe ; de là au Lualaba, *morsitans* en grand nombre.

(2) *De Bukama à Mutombo Mukulu.*

Parc typique jusqu'à Songe ; parc un peu dégénéré de Songe jusqu'à la Lovoï (un peu avant) ; ensuite, savane.

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*Pour tous les voyages voir la carte annexée.

Nombreuses *morsitans* jusqu'à Songe ; rares *morsitans* depuis Songe jusqu'à la Lovoï ; plus une seule *morsitans* depuis la Lovoï.

(3) *De Kisengwa* (*Lomami*) *à Ankoro* (*Lualaba*).

De Kisengwa à Katompe végétation transitoire ; savane plus ou moins boisée avec des ilôts de forêt. De Katompe à Ankoro ; parc. Pas de *morsitans* jusqu'à un peu avant Katompe (ruisseau Luangoï) ; de là jusqu'à Ankoro nombreuses *morsitans* le long de toute la route.

Je signalerai en passant que depuis la rivière Luvidjo jusqu'à Ankoro on ne traverse pas un seul ruisseau constant. Jusqu'à Pangankolwa (huit kilomètres avant Ankoro) ce n'est qu'un seul plateau boisé (parc typique) abondant en toutes espèces de gibier ; buffles, antilopes les plus variées, cochons sauvages, etc. Pas une goutte d'eau à proximité de la route (en saison sèche) pendant environ 35 kilomètres ! Eh bien, je n'ai jamais vu autant de *morsitans* que sur ce plateau.

(4) *De Kikondja à Kasongo Niembo* (*lac Samba*).

Parc presque continu, mais un peu dégénéré, jusqu'à la Lovoï. Depuis cette dernière rivière le parc non seulement devient peu typique, mais il est encore très souvent entrecoupé par des plaines herbeuses ou par d'assez grandes étendues peu boisées. Je parle, bien entendu, des environs de la " route " laquelle, simple sentier indigène, serpente d'un village à l'autre.

On voit donc que la limite du parc est ici très vague, ce qui n'est nullement étonnant quand il s'agit d'un genre de végétation qui couvre une vaste étendue de milliers de kilomètres carrés et qui cède peu à peu sa place à un autre genre de végétation (savane), qui couvre également une vaste étendue et qui finira par céder sa place à la vaste forêt équatoriale, laquelle enfin n'a pas de limites bien nettes non plus.

Mais quelle est la conduite dans cette région, entre la Lovoï et le lac Samba, de la *morsitans*, de cette fidèle compagne du parc ? L'accompagne-t-elle jusqu'à l'endroit, à l'ouest de Samba, où il cède définitivement sa place à la savane, ou l'abandonne-t-elle déjà avant ? Eh bien, voici ce qui s'y passe.

Depuis Kikondja jusqu'à la Lovoï la *morsitans* est constante, quoique bien rare ; mais depuis la Lovoï la *morsitans* devient aussi peu constante et aussi " vague " que notre parc. Pendant les quatre jours que j'ai mis de la Lovoï au lac Samba, j'ai vu tous les jours la *morsitans*, seulement je n'en ai vu qu'une ou deux par jour, et (dois-je même le dire ?) uniquement dans les endroits où le parc était encore plus ou moins " convenable," c'est à dire assez typique et assez étendu. J'ai indiqué sur la carte les quatre endroits où j'ai trouvé ces rarissimes *morsitans* et on remarquera que j'ai encore trouvé une *morsitans* sur le Mont Lubu (" Lubu " veut dire, en Kiluba, mont), à une dizaine de kilomètres de Samba.

On voit donc qu'aux limites nettes du parc correspondent des limites nettes de la *morsitans* et que quand le parc ne se termine que par une transition très lente, la *morsitans* fait de même. Certes, pratiquement on peut faire abstraction de ces quelques exceptionelles *morsitans*, qui se trouvent entre la Lovoï et Samba (dans le voisinage de la route suivie par moi), mais elles existent quand même.

Un jeune et distingué confrère qui a voyagé il y a quelques années entre Kabongo, Kikondja et Bukama et à qui j'ai un peu exposé, l'an passé, ma théorie du " parc,"

m'écrit entre autre ceci : " Je ne suis pas parti (pour Bukama) moi-même de Kasongo Niembo, mais de Kabongo, et me suis dirigé droit vers le Sud par Kako, Kaswamande, etc. (voir carte). C'était en juin. Je n'ai plus trouvé de *morsitans* (ni de *palpalis*, bien entendu) à partir de Kako ; et pourtant quel admirable " parc " et fourni en gibier ! Pourquoi ? Mystère. Il existe ainsi des régions privilégiées, on ne sait pourquoi. J'attends de vous des éclaircissements à ce sujet."

Mes " éclaircissements " les voici :

Il est parfaitement exact qu'il y a des régions " privilégiées " en tout, en *morsitans* comme en autres choses, mais cela ne doit pas nous empêcher de chercher ni d'établir des principes généraux. Sans parler déjà de ce qu'une exception n'infirme pas une régle générale.

La *morsitans* habite une vaste étendue de l'Afrique centrale et australe couverte d'un genre de végétation appelé " parc." C'est une règle ou plutôt une constatation générale. Mais il y a des régions du même parc où la *morsitans* pullule, et d'autres où elle est très rare. Cela c'est un détail, au point de vue théorique du moins, un commentaire du principe général. Vers la limite du grand parc, laquelle n'est en général pas brusque, la *morsitans* devient de plus en plus rare, de sorte qu'il y a des morceaux de parc terminaux, ou limitrophes, où la mouche n'existe plus, ou existe en quantité si minime qu'on a beaucoup de peine de la découvrir et qu'on peut passer sans l'avoir aperçue.

La région dont parle mon confrère, au sud de Kako, est justement l'extrémité occidentale du parc. Le parc de cette région n'est nullement " admirable," mais dégénéré et inconstant. Et quant à la *morsitans*, elle existe donc bel et bien au sud de Kako et Kaswamande, quoique en très petit nombre.

Je dirai donc, en résumé, que *la limite occidentale de la* morsitans *coïncide avec celle du parc, mais il semble que là où la limite du parc est peu nette, la* morsitans *disparait parfois avant la terminaison complète du parc.*

Cette limite double n'est pas une ligne, ni même une bande droite, mais une courbe et ne coïncide par conséquent avec aucune longitude. A la hauteur de Bukama (un peu plus au nord) notre limite coïncide avec la Lovoï ; plus au nord elle s'arrête avant la Lovoï ; encore plus au nord elle dépasse cette riviere. Mais dès qu'on atteint la latitude de Kasongo Niembo, on constate une coïncidence très curieuse et intéressante ; en effet, dans les environs de Kasongo Niembo, de Kabongo et de Kisengwa la limite du parc (et de la *morsitans*) coïncide avec la ligne de faîte Lualaba-Lomami.

Dans le " Rapport sur les travaux de la mission scientifique du Katanga " (1910–1912), que j'ai reçu tout dernièrement, se trouve un chapitre consacré à la dispersion et à la biologie des diptères hématophages, rédigé par M. Bequaert, entomologiste de la mission Rodhain. En parlant de la *morsitans*, M. Bequaert dit, entre autre, ce qui suit (page 247) :

" En ce qui concerne la limite occidentale de la *Glossina morsitans*, nous sommes un peu mieux renseignés. Nous avons pu constater personnellement qu'à partir de Kabalo cette mouche est abondante sur la rive droite du Lualaba. Dans le nord du Katanga, nous n'avons pu constater sa présence sur la rive gauche de ce fleuve, sauf dans la région d'Ankoro, où cette mouche est d'ailleurs très rare. Aussi croyons

nous qu'entre le 6° et le 8° parallèle, le cours du Lualaba constitue à peu près la limite occidentale de la *morsitans* ; elle n'existerait sur la rive gauche qu'à l'état de colonies sporadiques."

Après ce qui a été dit plus haut on voit que M. Bequaert se trompe et que le Lualaba n'est nullement la limite occidentale de la *morsitans*.

Quand enfin aux hauts plateaux où la *morsitans* n'existe pas, c'est encore et toujours à cause de la végétation. Dans le temps j'ai également voulu déterminer le maximum de l'altitude où on peut encore trouver cette espèce, mais je me suis vite aperçu que la *morsitans* disparaissait à la même altitude que la végétation arborescente, c'est à dire à 1,400–1,600 mètres, suivant les régions.

En effet, ceux qui ont visité le Marungu, le Biano et d'autres hauts plateaux du Katanga savent que ces plateaux sont couverts exclusivement d'herbe (savane ou steppe).

QUELQUES OBSERVATIONS PRÉLIMINAIRES SUR LES MOEURS DE LA GLOSSINA BREVIPALPIS.

Par le Docteur SCHWETZ.

(CARTE I.)

La *Glossina brevipalpis* est certainement l'espèce de glossine la plus répandue, dans certaines régions du moins, après la *G. morsitans* et la *G. palpalis*, mais elle a des moeurs si particulières que, sans les connaître, on ne peut découvrir son existence que par un simple hasard. En effet, les moeurs de la *G. brevipalpis* sont vespérales et, en partie, matinales, après le lever et surtout avant et après le coucher du soleil. Durant le reste de la journée la mouche est complètement inactive et se tient cachée (dans les herbes ?).

Il en résulte qu'on peut traverser de nombreux endroits et même des régions entières sans avoir vu une seule *brevipalpis*, quoique cette dernière s'y trouve en très grand nombre.

Une autre particularité importante de la *brevipalpis* est de ne pas voler si haut que la *morsitans* et la *palpalis*, mais de voltiger par terre. Il en résulte que même en se promenant au moment propice on risque de ne pas apercevoir la *brevipalpis* si on ne la cherche pas, soit en regardant par terre, soit en écoutant attentivement le bruit tout à fait spécial du vol de cette mouche très curieuse. C'est surtout le cas pour ceux, c'est à dire pour tous les Européens, qui sont chaussés et qui ne risquent par conséquent pas d'être piqué. Les noirs s'en aperçoivent bien, étant parfois cruellement piqué dans les jambes.

Je vais exposer brièvement mes quelques observations sur les moeurs de la *G. brevipalpis* et on verra par cet exposé que les deux particularités signalées ne sont pas les seules qui distingue ses moeurs des autres espèces de glossines.

Pour pouvoir bien étudier les moeurs d'un insecte il faut pouvoir les observer régulièrement et pendant longtemps. J'ai malheureusement été empêché de le faire en ce qui concerne la *brevipalpis*. Non seulement toute la région de Kabinda, où j'ai mon poste fixe, en est complètement exempte, mais presque tout le district du Lomami, sauf la partie nord-est. Je n'ai donc pu observer cet insecte que pendant mes voyages, c'est à dire en passant.

Comme toutes les autres glossines, la *brevipalpis* a besoin d'ombre, c'est à dire qu'elle n'existe que dans les endroits boisés. Nous verrons plus tard que pour devenir active il lui faut même une certaine fraicheur. Quant au voisinage de l'eau la *brevipalpis* occupe sous ce rapport une place intermédiaire entre la *palpalis* et la *morsitans*. Tandis que la *morsitans* se trouve également dans des endroits très éloignés de tout réservoir d'eau et la *palpalis* n'existe que dans le voisinage immédiat de l'eau, le long ou autour de l'eau, la *brevipalpis* se trouve à *proximité* de l'eau, c'est à dire depuis la rivière, par exemple, jusqu'à une certaine distance d'elle.

La *brevipalpis* s'accomode à toute espèce de végétation arborescente, depuis quelques arbrisseaux éparpillés, jusqu'à la galerie forestière inextricable des rivières. Mais ce sont les chemins et sentiers conduisant des villages à l'eau qui sont le lieu de

prédilection de la *brevipalpis.* Et voici ce qui s'y passe : On a beau rester sur un chemin pareil pendant toute la journée (ce que j'ai fait à plusieurs reprises), on ne verra pas une seule *brevipalpis.* Mais à une demi-heure environ avant le coucher du soleil elle apparait brusquement. En écoutant attentivement, on entend un bruit court du vol de la mouche, et en regardant par terre on l'aperçoit elle-même. Dès qu'on approche d'elle, pour l'attraper par exemple, elle s'envole, mais elle ne s'envole pas loin ni en haut ; elle se déplace seulement de quelques mètres plus loin, à la manière des " sauteurs," avec cette différence, qu'elle ne saute pas, mais voltige sur la surface du sol ou sur les herbes et buissons.

Le nombre des *brevipalpis* varie, bien entendu, suivant les endroits, mais, contrairement à la *G. fusca,* dont on ne trouve jamais que de rares spécimens isolés, la *brevipalpis* vit en vrais essaims, et il suffit d'en apercevoir une pour être sûr qu'il y en a, ou qu'il y en aura tout de suite, beaucoup d'autres. En effet, le nombre des mouches voltigeant sur le sentier augmente de plus en plus pour atteindre son maximum au moment du coucher du soleil. C'est le moment de la plus grande activité de la *brevipalpis.* Après cela elle devient de plus en plus rare pour disparaître complètement à une demi-heure environ après le coucher du soleil, à peu près au moment où la lecture devient impossible sans lumière. L'activité vespérale de la *brevipalpis* dure donc environ une heure. C'est donc pendant cette heure unique qu'il faut la chercher.

Il y a cependant un autre moment de la journée quand la *brevipalpis* devient plus ou moins active, voltige et pique probablement ; c'est le matin, après le lever du soleil, plus tôt ou plus tard, suivant qu'il fait plus froid, ou moins froid. Mais son activité matinale ne peut nullement être comparée à celle du soir, et dans les mêmes endroits où, le soir, la *brevipalpis* grouille, pour ainsi dire, on n'en trouve le matin que des exemplaires bien rares. A Katompe où l'espèce existe en grand nombre sur tous les sentiers environnants et où pendant quelques jours je m'en suis occupé exclusivement, je n'en n'ai pas vu du tout le matin (mois de juin), tandis que le soir ma " moisson " était toujours bien riche.

Il m'est arrivé enfin, ainsi qu'à mes gens qui m'aidaient dans cette besogne, de trouver, en me promenant dans des sentiers en question et surtout dans leur voisinage, une ou deux *brevipalpis* en plein jour ; mais on peut en faire abstraction, d'autant plus que ces rares exemplaires étaient certainement dérangés dans leur quiétude habituelle par le bruit et même par les secousses produites par la marche dans les herbes et buissons.

On sait que les glossines, comme d'ailleurs les mouches en général, sont plus ou moins réveillées la nuit par la lumière artificielle, mais la *palpalis,* tout en se mouvant plus ou moins dans ces conditions, reste cependant somnolente et ne pique pas. Il en est tout autrement avec la *brevipalpis.* Comme c'est à la tombée de la nuit que mes gens m'apportaient des *brevipalpis,* quelques-unes s'étaient échappées à plusieurs reprises dans ma tente même, et une fois la lampe allumée, elles devenaient si agiles que j'avais beaucoup de peine à les rattraper. Une de ces fugitives m'a parfaitement bien piqué à 9 h. du soir.

Abstraction faite de cette piqûre faite dans des conditions spéciales, je n'ai jamais été piqué par la *brevipalpis* malgré une vingtaine de soirées passées " en sa

compagnie." Cela se comprend d'ailleurs ; voltigeant par terre, la mouche ne peut piquer, ou du moins difficilement, celui qui porte un pantalon et est chaussé. En effet, mes porteurs qui cherchaient pour moi ces mouches ont été plusieurs fois piqués. Les indigènes m'ont dit également qu'ils étaient assez souvent piqués par la *brevipalpis* dans les jambes e se rendant, le soir, à l'eau et en venant. Néanmoins il est un fait que la *brevipalpis*, moins agile que les autres glossines, est également moins vorace qu'elles. Et si, au point de vue de la voracité ou de l'avidité, la *morsitans* occupe certainement la première place parmi toutes les tsé-tsés, il faut placer, au même point de vue, la *brevipalpis* après la *palpalis*. Sur plus de mille *brevipalpis* capturées je ne me rappelle pas avoir vu plus de deux ou trois avec l'abdomen distendu par du sang ingéré.

Notre mouche curieuse présente encore une autre particularité étrange et inexplicable. On sait que parmi les tsé-tsé capturées (et spécialement parmi les *palpalis*) on trouve plus de mâles que de femelles. Mais cette différence dans la proportion des mâles et des femelles n'est pas très grande ni constante. On peut dire qu'en général on trouve plus de mâles que de femelles et c'est tout. Mais il en est tout autrement avec la *brevipalpis*, dont on ne capture que presqu'exclusivement les mâles. On ne voit pour ainsi dire jamais de *brevipalpis* femelles, dont le nombre de capturées est tout à fait minime et n'atteint pas même 1 pour cent. En effet, sur plus de mille *brevipalpis* capturées et examinées je n'ai trouvé que trois femelles. Voici quelques détails : —

(1)	Sur	95	*brevipalpis*	capturées	à Kakanwe,	j'ai trouvé	1 femelle.
(2)	,,	312	,,	,,	à Katompe	,, ,,	2 femelles.
(3)	,,	373	,,	,,	à Kingo (Lufungoï)	,,	0 femelle.

Parmi les autres 200 environ capturées au nombre de 20 et 30 par localité je n'ai pas trouvé une seule femelle.

Le millier de *brevipalpis* en question a été capturé en saison sèche (juin et août) et j'aurais pu attribuer l'étrange phénomène aux causes saisonnières si je n'avais pas constaté la même chose en saison des pluies également. En effet, lors d'un passage antérieur par la même localité de Kakanwe, en février, je n'avais pas trouvé une seule femelle sur 26 *brevipalpis* capturées au moment du coucher du soleil. Et comme Kakanwe est la seule localité à *brevipalpis* que j'ai pu visiter trois fois, je m'empresse de noter qu'en février, saison des pluies, l'espèce y a été en plus grand nombre qu'au commencement de juin (commencement de la saison sèche), et qu'au mois d'août (fin de la saison sèche) cette mouche y a été encore plus rare qu'en juin.

La *brevipalpis* est assez répandue dans l'Afrique orientale allemande et dans le Nyasaland. Quant au Congo Belge, plusieurs spécimens avaient été capturés dans le sud du Katanga (par Neave et Stoehr) et à la rive occidentale du Tanganika et dans la vallée de la Lukuga (par moi). Mais la présence de la *brevipalpis* à *l'ouest du Lualaba* a été complètement inconnue jusqu'à présent. La carte ci-annexée démontre que l'espèce se trouve, à une certaine latitude du moins, non seulement entre le Lualaba et le Lomami, mais même un peu à l'ouest de cette rivière (à environ 25° L.E.). Cette carte me dispense d'énumérer les endroits où j'ai trouvé la *brevipalpis* et d'indiquer leur position géographique. On verra que tous ces endroits se trouvent entre le 5^e et le 7^e Par. S.

Je n'ai pas trouvé une seule *brevipalpis* dans le reste du district du Lomami (ni dans les régions voisines, à l'ouest du Lualaba) c'est à dire dans les territoires compris entre Kikondja, Bukama, Mutombo Mukulu, Kanda Kanda, Pania Mutombo, Kabinda, Tshofa, Kisengwa, Kabongo et Kasongo Niembo. Et pourtant j'ai parcouru toutes ces régions, et inutile de dire que pendant mes voyage je pensais également à la *brevipalpis.* Et si cela ne veut pas encore dire que dans les régions énumérées il n'y a pas de *brevipalpis* du tout, il est cependant plus que probable qu'elle est très rare.

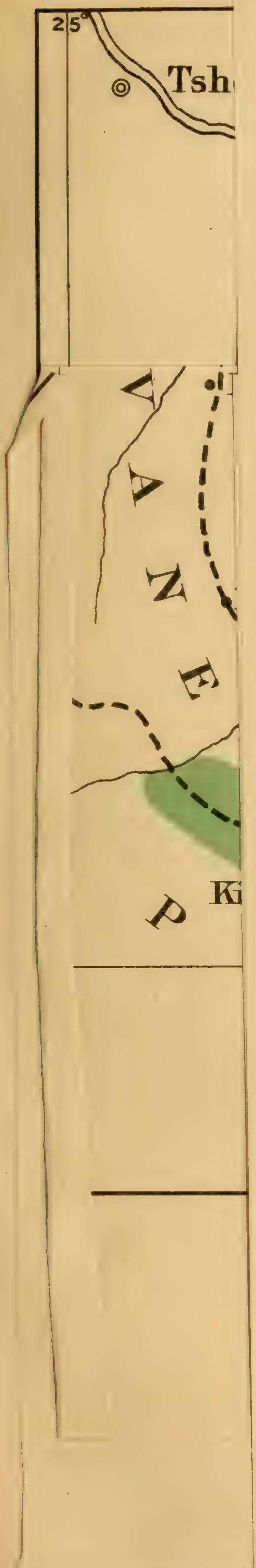
Pourquoi la *brevipalpis* est-elle si répandue dans certaines régions et complètement absente dans d'autres qui se trouvent cependant dans des conditions identiques ? Mais des questions de ce genre pourraient être posées en grande quantité sans grande chance d'obtenir une réponse plausible avant longtemps encore. Et si l'on peut encore expliquer la répartition de la *morsitans* (voir à ce sujet mes rapports-articles), ce n'est pas le cas en ce qui concerne la distribution de la *palpalis* ; dans certaines régions les moindres cours d'eau en sont infestés, tandis que dans des régions voisines, présentant cependant les mêmes conditions, on peut trouver d'assez grandes rivières sans *palpalis.*

Et pour revenir à la *brevipalpis*, j'ajouterai que la région comprise entre Katompe et Ankoro présente un parc typique complètement envahi par la *morsitans*, qu'entre Kisengwa et Katompe on a une végétation intermédiaire ou transitoire sans *morsitans*, et qu'entre Kisengwa et Tshofa on a la savane typique avec des galeries forestières le long des rivières et ruisseaux et, ce qui va sans dire, sans *morsitans.* La *brevipalpis* habite dans toutes ces régions présentant une végétation variée et différente.

Voilà les quelques constatations que j'ai pu faire concernant les moeurs de la *brevipalpis*, constatations, pour ainsi dire, exclusivement entomologiques. Mais ce qui est surtout important au point de vue médical, c'est de connaître le rôle que joue, ou peut jouer, la *brevipalpis* dans la transmission de la trypanose en général et de la trypanose humaine en particulier.

Tout en étant relativement peu vorace ou avide, la *brevipalpis* pique cependant. Elle se tient le soir et le matin sur les chemins, c'est à dire où et quand les indigènes vont à l'eau. Et si dans quelques endroits le nombre de l'espèce est si restreint qu'on peut en faire abstraction, dans d'autres, par contre (par exemple à Katompe et à Kingo), où, entre parenthèse, la maladie du sommeil à fait il y a quelques années de très nombreuses victimes, la *brevipalpis* existe en si grand nombre que, comparativement, on peut faire abstraction des *palpalis* de ces localités.

Cette question si intéressante au point de vue scientifique et si importante au point de vue pratique, n'a pas encore été étudiée (autant que je le sache). Pour des raisons que j'ai exposées plus haut, il m'a été tout à fait impossible de commencer l'étude de cette question et je me vois forcé pour le moment de me borner à la toucher, à la poser. D'ailleurs mieux tard que jamais.


25°
Tsh
V A N E
P
Ki


Carte du District du Lomami (Katanga, Congo Belge) et de la région orientale voisine, illustrant la répartition de la
GLOSSINA BREVIPALIS
et la limite occidentale de la
G. MORSITANS
Echelle 1/1,000,000
Route suivie
Glossina brevipalis
" morsitans
Copie de la Carte H. Broogmans
25°
26°
27°
6°
7°
8°
9°
Tshofa
Lusanga
Fuamba
Limai
Kongolo
Ya-Mulimbi
Kifukutu
Lukasi
Kekaie
Bulanda
Mulenda
Kisengwa
Peko
Kabambale
SAVANE BOISÉE
Katompe
Lufungoie
Kabalo
Kingo
LOMAMI
Lukashi
Kakanwe
Mwana Tshofa
Tambaie
Kabi
Kukwe
Kimoto
Kihombo
Kaie
PARC
Mumbu
Malangu
Mokombo
SAVANE
Panganko1wa
Ankoro
Musengay
Luvidjo
Masengo
Luguvo
LOMAMI
Kabongo
Kakolwe
Kako
PARC DÉGÉNÉRÉ
Kimisundu
Kaswamanga
Kasolo
Lac Sambo
Lulu
Kasongo Niembo
PARC DÉGÉNÉRÉ
Kadibua
Kasakaie
Yamba
Matabongo
Kakongolo
LUALABA
Kabwe
Kilubi
Kembe
Kapapa
Kole
Toadji
Kikondja
Tshikala
Lac Kisale
Lubinda
Lovoi
Songo-Mongo
Kisulo
Kasipa
SAVANE BOISÉE
LUALABA
Luila
Kamashi
Songe
Kishiro
Bukama

A PRELIMINARY NOTE ON THE IDENTIFICATION OF SANDFLIES.

By F. M. Howlett,

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(Plates XI and XII.)

Some form of short-period fever, apparently sandfly fever, seems to have been giving trouble in the Gallipoli area. This fact, together with the small amount of information at present available on the life-histories of the species comprising the genus *Phlebotomus*, has led me to publish the present note in the hope that it might be of use to medical officers by giving them easily-seen characters by which the early stages of three species may be differentiated. In collaboration with my assistant Mr. Patel, I have been engaged for some time in collecting material for a complete account of the life-histories of these species, but as the publication of this memoir must be deferred to a later date, the present article contains merely a few points which are likely to prove useful under practical conditions of working in the field, and a note on the very curious larval tail-bristles.

The three species dealt with are those commonly found in India, *Phlebotomus papatasii*, *P. argentipes*, and *P. minutus*. The first and last are already known to occur in Southern Europe.

The adult characters can be ascertained from the excellent works of Grassi, Newstead, Annandale and Brunetti, and others; the male genitalia are reliable and easy characters, but the distinction of the females is not so easy.

The pupae, to the tail of which the shrivelled larval skin remains attached, can be differentiated by the structure of the genitals and caudal extremity generally, as revealed by gently removing this larval skin, and by the number and arrangement of the small excrescences bearing spines or bristles situated in the humeral region of the pupa.

But for practical purposes the characters of the egg and newly hatched larva are most valuable, since almost any female which is caught full of blood will lay eggs within a couple of days, if kept in an ordinary specimen-tube plugged with cotton wool and containing a piece of wet blotting-paper which is not allowed to dry up. Young larvae will hatch out under the same conditions in a week or ten days, and either egg or young larva affords easy means of identification.

Egg-characters.

When freshly laid the eggs of all three species are white, but they ultimately become yellowish brown in *papatasii*, and smoky or dark brown in *minutus* and *argentipes*.

The egg of *papatasii* is the largest, *argentipes* intermediate, and *minutus* the smallest, the last-named being about five-sixths the size of *papatasii*. The egg of *papatasii* is drawn to scale in fig. 1, Pl. xi.

The pattern shown by the slight sculpturing on the surface easily differentiates the species, as follows:—

Lines on the surface slightly wavy and irregular, joined at irregular intervals by fainter cross-lines .. .. *P. papatasii.*

Longitudinal lines more numerous and more regular, as are also the cross-lines which join them, so that the pattern appears to be made up mostly of narrow parallelograms .. .. *P. argentipes.*

The pattern appears to be made up of juxtaposed circles forming cells of roughly hexagonal shape .. .. *P. minutus.*

The egg-patterns are shown on Pl. xi., figs. 1, 2, 3, and 5.

Characters of newly-hatched larvae.

The two characters which are most quickly and easily recognised are the relative length of the tail-bristles as compared with the head and body, and the shape of the body-bristles. The dorsal bristles of the segments forming the posterior part of the abdomen are generally easiest to examine, and the three characteristic shapes are best seen in the figures on Pl. xii. These figures were very carefully drawn with the camera, and show the bristles in newly hatched and adult larvae.

The points of difference are:—

(1) The straightness or curvature of the bristle.

(2) The relative thickness of the apical and basal portion compared with its total length.

(3) The outline of the apical portion.

The relative length of the large tail-bristles as compared with the body can be roughly expressed thus:—

Ratio of length of body with head to length of tail-bristles = 6 : 5 in *papatasii* larvae, = 5 : 5 in *argentipes*, = 4 : 5 in *minutus*.

Hatching of the Egg.

Just before hatching a slight motion of the egg can sometimes be detected, ultimately resulting in the appearance of a longitudinal split in the antero-lateral region, extending about half the length of the shell. Probably this split is started by means of what we have called the "egg-tooth," but the shell is not sufficiently transparent to enable one to make sure of this. Figs. 4 and 5, Plate xi., show the young larva hatching. It gets free of the egg-shell in somewhat less than a minute. There is often another split in the shell running round to the dorsal surface. When this second split is not made, the shell does not collapse after hatching, but, save for its lighter colour, looks as if it were intact. The characteristic pattern can be well seen on the surface of empty egg-shells, and this, combined with the relative length of the body and tail-bristles of the newly hatched larva, gives an extremely easy and reliable identification of any one of the three species mentioned in this paper.

The habits of the larvae are interesting, but cannot here be dealt with at length. The function of the tail-bristles is not yet fully understood, although they form such a characteristic feature. The larvae cannot burrow,

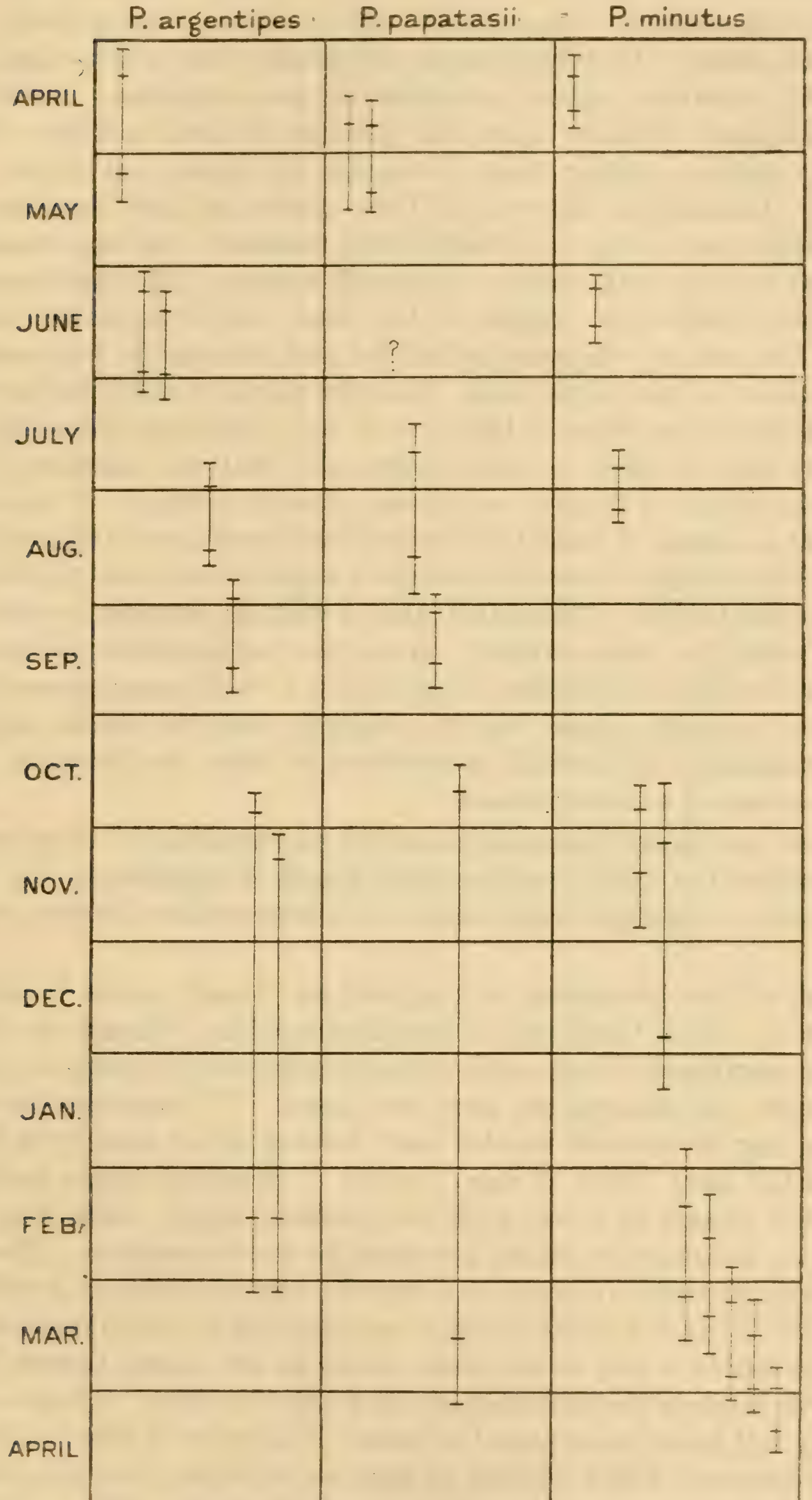


Fig. 1. A diagram to show the duration of the egg, larval and pupal stages of three species of *Phlebotomus* at different seasons of the year.

but hide themselves in dark crevices and cracks, holding on by the processes of the posterior part of the body so as to leave the head free for feeding. On the approach of danger they will generally "sham dead," becoming perfectly motionless. The older larvae are usually less active than the young ones, and will sometimes remain motionless for hours together. In this condition they are particularly difficult to see, the particles of earth and dirt which adhere to the body-bristles making them harmonise in colour and texture with the background. Although the larvae of all three species are thus inert, they are quite capable of rapid and abrupt movement when irritated. On one occasion a small mite was seen walking on the body of a larva (*P. minutus*); the larva remained quiet until the mite reached the region of the head, but then started energetically "fighting" the mite by whipping up the tail and bringing its long caudal bristles into play against the back of the head. Since the places in which the larvae generally live are of a kind where there is likely to be risk from small wandering predators and parasites such as mites, it is not improbable that one function of these very curious caudal bristles is to serve as a means of active defence. It is also probable, however, that as organs of touch they serve a useful purpose at all times, while there is another curious habit of these larvae which might be supposed to have a bearing on the use of the bristles. This is the habit of walking backwards which the larvae possess and which they often exhibit; no one who has seen them do this could deny that the nodding plume of bristles in front gives a very strong impression that the advancing tail is really a head, but it is unlikely that the normal enemies of the larvae are sufficiently intellectual or fastidious to make the deception of practical utility as a means of avoiding attack.

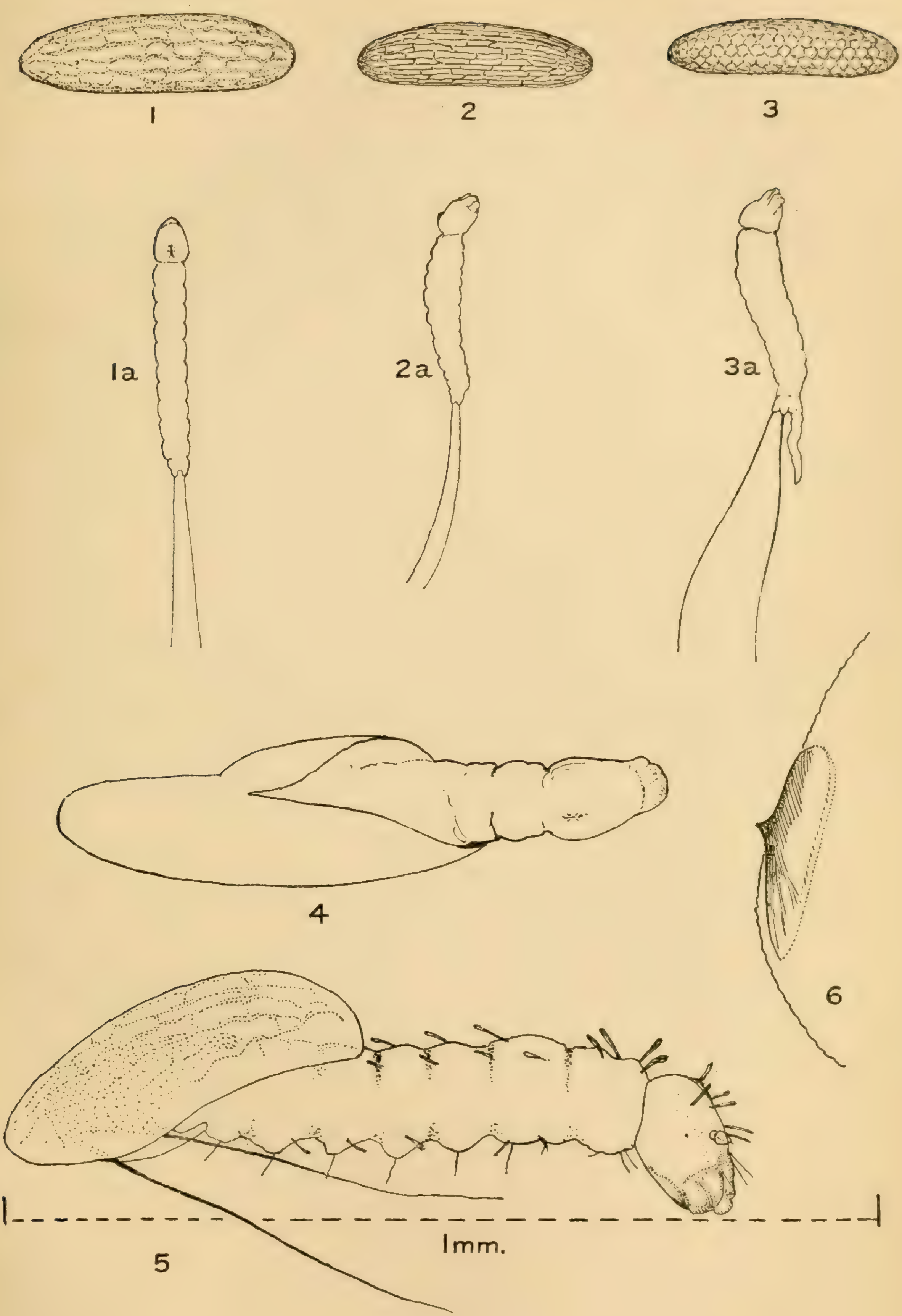
There exists one simple bionomic character, the influence of temperature, which also differentiates the species and has some practical importance. In this respect, as in some others, *argentipes* seems more or less intermediate between *papatasii* and *minutus*.

The length of the life-history in a typical lot of each species is indicated in a diagram (fig. 1). From this it will be seen that *minutus*, although its life-history is considerably lengthened, breeds more or less continuously through the cold weather at Pusa, where our observations have been made. *P. argentipes* larvae hatching at the beginning of the cold weather may develop either quickly or slowly (even larvae from the same batch of eggs); while *P. papatasii* larvae hatching at the same time will remain as larvae until the following spring, when they pupate and emerge in late February or March according to the temperature. The interesting case of *argentipes* recalls my experience with the eggs of *Stegomyia scutellaris*; when a batch is laid at the end of the autumn, one may find a certain number of the eggs hatching out within a day or so, while others do not hatch, though they remain alive and will hatch in the following spring if kept in water. If kept dry for a few months they will hatch when placed in water. The cause of these variations in the rate of development of late batches of eggs, or of larvae from the same batch of eggs and kept in the same vessel, would form an interesting subject of study.

Explanation of Plate XI.

Eggs and Larvae of *Phlebotomus*.

Fig. 1.		Egg of *P. papatasii*.
	1 *a*.	Newly hatched larva (slightly less magnified).
	2.	Egg of *P. argentipes*.
	2 *a*.	Newly hatched larva (slightly less magnified).
	3.	Egg of *P. minutus*.
	3 *a*.	Newly hatched larva (slightly less magnified).
	4 & 5.	Larva of *P. papatasii* emerging from egg.
	6.	Egg-tooth of *P. papatasii* larva.



EGGS AND NEWLY HATCHED LARVÆ OF INDIAN PHLEBOTOMUS.

Explanation of Plate XII.

Larvae of *Phlebotomus*.

Fig. 7. *P. minutus*, left antenna of larva, side view.

8. „ head of larva, „

8*a*. „ „ front view from above.

9. „ dorsal bristle of 2nd thoracic segment of larva.

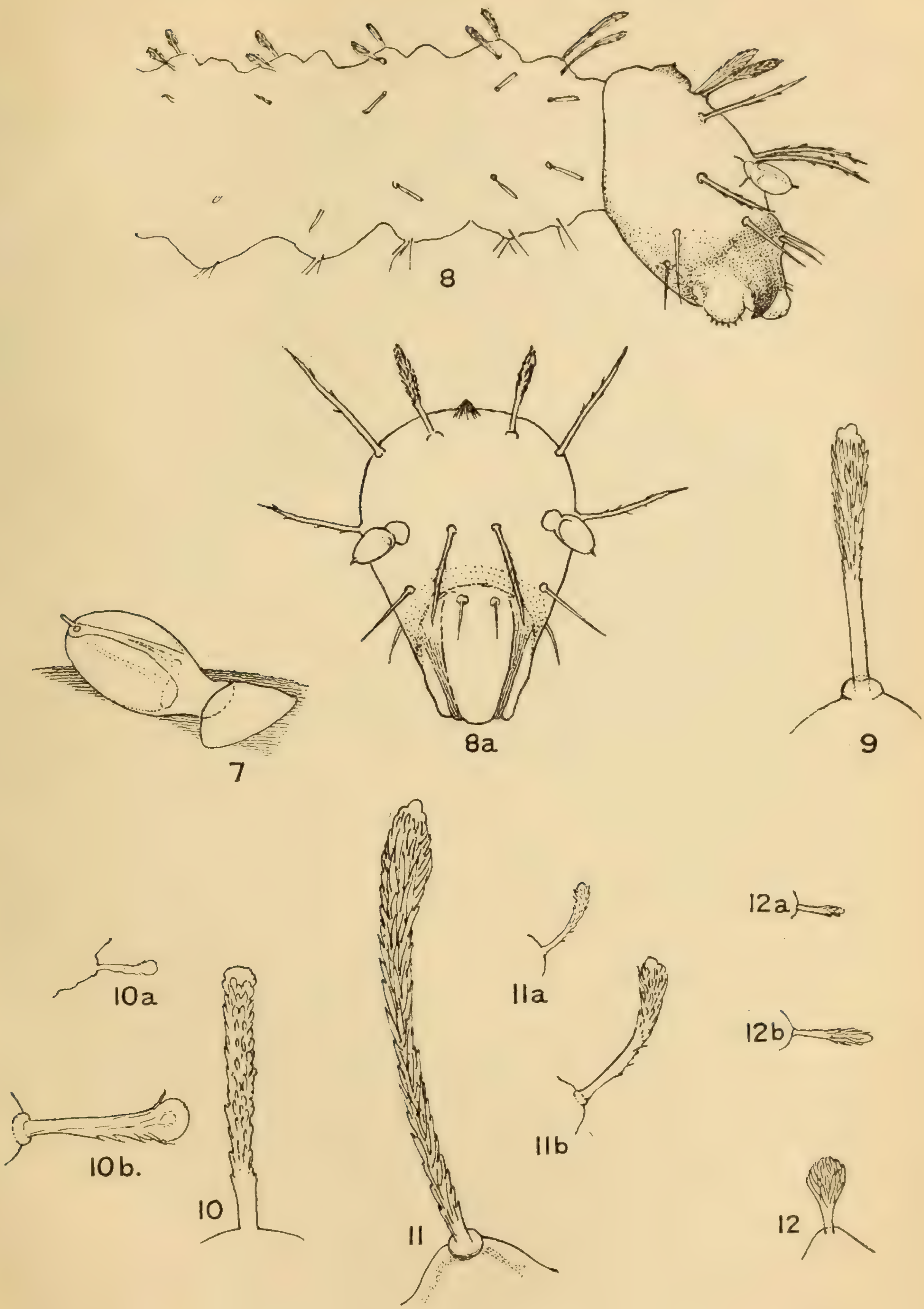
10. *P. papatasii*, dorsal bristle of posterior abdominal segments of full-grown larva.

10*a*. *P. papatasii*, dorsal bristle of posterior abdominal segments of newly hatched larva on same scale as (10).

10*b*. The same, more magnified.

11, 11*a*, 11*b*. *P. argentipes*, a similar set of dorsal bristles.

12, 12*a*, 12*b*. *P. minutus*, „ „ „



LARVÆ OF INDIAN PHLEBOTOMUS.

CHEMICAL REACTIONS OF FRUIT-FLIES.

By F. M. Howlett.

(Plates XIII–XVI.)

In 1912 I published some observations* on the strong attraction of oil of citronella for the males of *Dacus* (now *Bactrocera*) *zonatus*, Saund., and *D. diversus*, Coq., and put forward some theoretical considerations regarding the influence of smells on such insect activities as pairing, egg-laying, and food-finding, on the assumption that their olfactory sense may have a specialised receptivity for a few particular "directive" smells or groups of smells, while remaining relatively unaffected by smells outside these regions of susceptibility. If, as I then believed, citronella represented a sexual smell attractive to males of two different species, it was probable either that there were two substances present, each of which attracted one species, or that the two species were not really distinct.

The publication of Prof. Bezzi's excellent monograph on the Indian Trypetids showed me that whereas I had been dealing with what I took to be only two species of *Dacus*, individuals of what I had regarded as merely a melanic variety of *D. zonatus* were really the form identified by him as *D. ferrugineus.* These individuals had also been seen attracted by citronella in the course of the earlier experiments (March), but disappeared later. It should be noted that the characters distinguishing *zonatus* from *ferrugineus* are purely those of colour ; I have up to now not seen any definite morphological distinction, and the question of the relationship between these two forms is one of some interest, to which I refer later.

In these observations I discriminate as far as is practicable between *zonatus* and *ferrugineus*, taking as my criterion of the latter a more or less dark thorax and a wing approximating in pattern to that shown in fig. 3, Pl. xiii. Typical forms of *zonatus* and *ferrugineus* are shown in figs. 1 and 3, Pl. xiii., but between these two many gradations in colour and wing-pattern can be found. My investigation this year thus started with the knowledge that males of three species, *diversus*, Coq., *zonatus*, Saund., and *ferrugineus*, F., were all attracted by citronella. If these three species are distinct, there must (I imagined) be three distinct compounds present in citronella, each attracting one species only.

In the course of the year 1912 I had tried a very large number of experiments with about twenty varieties of essential oils in order to discover whether there were other substances attractive to the flies. These oils were tried alone, mixed with one another in various proportions, and mixed with citronella, certain vegetable oils, and other substances. From these experiments it was soon evident that the flies perceived the smell of small quantities of citronella mixed with almost any other substance, even though the smell was so faint as to be almost imperceptible to me even at close range. In the absence of citronella no definite attraction was noted save in the following cases :—

(1) One sample of oil of eucalyptus, origin and composition unknown ;
(2) a mixture of clove oil, coconut oil and kerosene ;
(3) a mixture of clove oil and eucalyptol.

* Trans. Ent. Soc., Oct. 1912.

In each of these cases a faint attraction (strongish in (2)) for *diversus* was noted, but apparently not for *zonatus* or *ferrugineus*. No other samples of eucalyptus were attractive, and I therefore neglected result (1).

I was unable to get analyses of the citronella used, and relied at first upon a partially correct statement that the main constituents of the oil were citronellal, citral, citronellol and geraniol. All these were tried many times, both alone and mixed in various combinations and proportions, but none had any attraction whatever.

In March of 1913 I got more accurate information regarding the constituents of oil of citronella. In the new (1911) edition of Thorpe's "Dictionary of Applied Chemistry" these are given as follows:—

Geraniol, citronellal, camphene, dipentene, limonene; with small amounts of linalol, borneol, methyl eugenol, methyl heptenone, and sesquiterpenes.

Now the previous experiments had shown quite clearly that the attraction of citronella was not diminished by admixture with other substances of a more or less similar character, and I felt justified therefore in ruling out of consideration all those constituents in the above list which also occurred in reasonable quantity in any of the oils which I had previously found unattractive. These were as follows: Geraniol, citronellal, camphene, dipentene, limonene, linalol, borneol and methyl heptenone. That is to say, out of the list given by Thorpe, the only definite constituent of citronella which had not been tested in the series of trials of different oils was methyl eugenol. This substance occurs in fair quantity in oil of bay, which had not been included among the oils tried. I obtained some bay oil and exposed it, and was pleased to find that it was very definitely attractive, five *ferrugineus* settling in the bowl in the course of twenty minutes, although the weather was distinctly unfavourable. It proved subsequently to be a considerably better lure than citronella for both *ferrugineus* and *zonatus*.

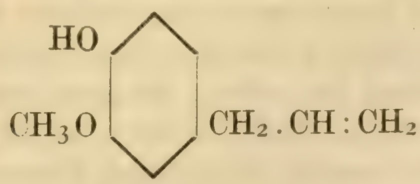
As already mentioned, some degree of attraction for *diversus* had also been shown by (*a*) a particular sample of eucalyptus; I decided to neglect this result for the time being, as the origin of the sample was unknown, and no other sample showed any attraction; (*b*) two mixtures containing clove oil.

Clove oil consists of 70–90 per cent. of eugenol, but it also contains eugenol acetate and furfurol, as well as methyl alcohol and salicylic acid. Bay oil contains eugenol and methyl eugenol, as well as chavicol, estragol and two terpenes. Citronella contains methyl eugenol, but its composition varies very much and it is largely adulterated.

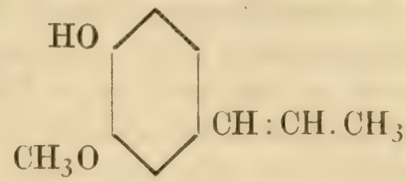
This seemed to confirm the connection between attractiveness and eugenol or some compound connected with or derived from it. Since eugenol itself constitutes from 70–90 per cent. of clove oil, it was to be presumed that the attractiveness lay in some other compound, as otherwise we might expect clove oil to be more attractive than citronella, whereas the reverse is the case. It seemed probable, then, that the attractive substances were derived from eugenol and were relatively abundant in citronella as compared with clove oil. The substance attractive to *ferrugineus* might be methyl-eugenol.

As I was not at once able to obtain any methyl-eugenol, I experimented on the effect of boiling clove oil with amyl alcoholic potash (KOH dissolved in amyl

alcohol); this treatment converts eugenol into the isomeric compound iso-eugenol. The relation between the two compounds is shown by the formulae below, the hexagons being benzene rings:—



Eugenol.



Iso-eugenol.

It will be seen that the difference lies in a rearrangement of the hydrogen atoms in the side-chain. The effect of boiling with amyl alcoholic potash was vastly to enhance the attraction of clove oil for *diversus*, so much so that it competed successfully with citronella. It appeared also to be somewhat attractive to *ferrugineus*, but less so than to *diversus*; *zonatus* had not appeared at this season.

The relative attraction of bay oil and citronella were next tested by exposing a rag wet with citronella and a bowl of water into which a little bay oil had been stirred. The rag and bowl were placed a few feet apart. The result was that in two hours 32 *diversus* and 14 *ferrugineus* were caught on the citronella rag, while the bay oil was visited *exclusively* by *ferrugineus* and 27 of this species were caught at it; *zonatus* did not appear (10.iii.13). Citronella contains methyl-eugenol and very probably also eugenol and iso-eugenol; bay oil contains methyl-eugenol and eugenol.

This result was the first definite indication of the possible existence of specific attracting substances for *diversus* and *ferrugineus* respectively. As *zonatus* was still absent or exceedingly scarce, it was not yet possible to observe its behaviour towards the two oils. As I have said above, at the time when my former paper on this subject was written I regarded *ferrugineus* and *zonatus* as being no more than varieties of the same species. My immediate object now was, assuming the "*ferrugineus*-attractor" present in bay to be one single compound (methyl eugenol?) and not a mixture, to obtain a pure sample of this compound. On my view that the attraction was to be regarded as a specific character, it follows that such a pure sample could be used as a touchstone on *zonatus* to determine its degree of affinity to *ferrugineus*. The natural oil-mixtures are so complex and so often adulterated that they are untrustworthy,

I procured from Messrs. Merck samples of eugenol, iso-eugenol, methyl eugenol, and benzo-eugenol. By the time I was able to test them (May) all three species, *diversus*, *ferrugineus* and *zonatus*, were present, but typical *ferrugineus* were rare, the form present in fair numbers being the intermediate one shown in fig. 2, Pl. xiii. I exposed these four substances in the usual way in small basins placed a foot apart on a table in my garden, each basin containing about a pint of water with a few drops of the substance stirred up in it. The result was very interesting:—

Eugenol attracted nothing.
Iso-eugenol attracted *diversus* very strongly; a few *ferrugineus*.
Methyl-eugenol attracted *zonatus* very strongly; many *ferrugineus*.
Benzo-eugenol attracted nothing.

At this season *diversus* was not abundant, but the numbers of both *diversus* and *zonatus* which came to the iso-eugenol and methyl eugenol respectively, and the promptness with which they appeared at the bowls, were very striking. As I walked carrying the methyl-eugenol bowl, from my bungalow to the table on which the bowls were exposed, a distance of about fifty yards, it was most pleasing to see three *zonatus* settle on the bowl before I had reached the table. Similarly, six *diversus* were noted at iso-eugenol when it had been in place five minutes. In two morning exposures of about two hours each 275–300 *zonatus* were found drowned in the methyl-eugenol bowl, and 48 *diversus* in iso-eugenol. The quantity of each substance in a pint of water was about 2 cc., but 0·5 cc. was equally effective.

The attraction of *ferrugineus* was apparently not quite so definite; though the majority of those seen went to the methyl-eugenol, iso-eugenol seemed (particularly when stale) to have an attraction for them. On some occasions a certain number of *zonatus* have also been seen at iso-eugenol, once or twice when methyl eugenol was not present, often when the iso-eugenol bowl was to leeward of one containing methyl-eugenol. Under these circumstances the flies, which seem invariably to come up the wind, if there is any, will often explore and sometimes remain in bowls which contain substances other than the one they presumably came for.

At one period, after rather heavy rain has fallen, some very anomalous results were obtained, but it appeared that these were due to rain-splashes from the different bowls, which were then placed at a distance of not more than about eight inches one from another. After cleaning the bowls and table with kerosene and spirit, the flies differentiated as usual. The delicacy of their perception will always introduce error unless care is exercised in filling and handling the bowls, for the trace of a thumb very slightly tainted with iso-eugenol has twice been seen to collect quite a little crowd of *diversus* at a control bowl filled with water. The attraction of methyl eugenol for *zonatus* and *ferrugineus* is very distinctly greater than that of the same quantity of bay oil, which again is greater than that of citronella. In the same way the attraction of iso-eugenol for *diversus* is very much greater than that of citronella.

The sharp distinction between the strong attraction of iso-eugenol for *diversus* and the relative failure of the isomeric eugenol (possessing a very similar kind of smell) is of interest. My experiments as a whole indicate that *diversus* is, practically speaking, not attracted at all by eugenol or methyl eugenol, though certainly it cannot be said that either is distasteful; *zonatus*, strongly attracted by methyl eugenol, is practically unaffected by eugenol or iso-eugenol, though it has perhaps a slight inclination to the former, and neither of them is distasteful; *ferrugineus* is not definitely attracted by eugenol, but may otherwise be said to be intermediate between *zonatus* and *diversus*, being definitely attracted by both methyl- and iso-eugenol. The definiteness of the reaction is indicated by figs.

In fig. 2, Pl. xvi., the two patches of moisture at the right and left-hand bottom corners of the paper represent dabs of a substance purchased as "methylate of iso-eugenol." This substance attracted all three species. I have not yet ascertained its actual composition; if it is the compound methylisoeugenol, the fact of its attracting all three species is of considerable interest, but it is otherwise if it is merely a mixture of methyl- and iso-eugenol.

My original view that these smells were direct sexual guides emitted by the females is quite unproved. In my former paper I described two experiments in smelling the females; in the first, an extremely faint aromatic smell could just be perceived, and in the second (with a larger number of females) a more distinct "citronelloid" smell, which was independently confirmed. Unfortunately, I discovered subsequently that for reasons against which it would be, in a civilised country, unnecessary to guard, this second experiment must be completely rejected. In the summer of this year I took several lots of living females, crushed their bodies between clean slips of glass, and exposed them in a place where males were present in some numbers, but they had no attraction whatever for the males. These females were all individuals that had emerged within the previous thirty-six hours, and the experiment to be quite conclusive should be repeated with an older batch.

If the smell is not a direct sexual guide, it might be

(*a*) a food-smell; involving the assumption that the feeding habits of the males are quite different from those of the females;

(*b*) a "rendezvous" smell, guiding males to the eugenol-derivative-producing plants on which the females were accustomed to rest; involving the assumption that the females decided on their resting-places for other reasons.

There are three plants on which males, but never females, have been seen to congregate in large numbers. These are the flowers of the Papaya (visited by *diversus* and *ferrugineus*), the female inflorescence of an Australian Cycad, and the spadix of the Aroid *Colocasia antiquorum* (both visited by *zonatus* and some *ferrugineus*). In none of these three plants have any of the flies been known to breed. All have a very uncommon smell, resembling that of eugenol derivatives. The males which congregate upon them seem to suck the surface of the plants, and this is consonant with a food-smell hypothesis, but they do not seem to exhibit any very special avidity. I have not been able to get any information as to whether or no eugenol-derivatives occur in the normal food-plants of the larvae.

Mr. C. S. Misra has collected *diversus* males which were swarming about mango-flowers in Coimbatore; it is noteworthy that *diversus* never, so far as I know, breeds in mangoes. Mr. Kunnikannan has, however, bred what is probably *ferrugineus* from a species of *Eugenia* at Bangalore, and as the genus *Eugenia* constitutes the main source of eugenol, some connection seems here to be indicated. On the other hand, although *zonatus*, *ferrugineus*, *cucurbitae*, *caudatus*, and (I believe) *diversus*, have all been observed, both males and females, resting under the leaves of the Jamun-tree (*Eugenia jambolana*) at Pusa, none have been found breeding in the fruits in spite of careful search.

The fact that the reaction is rigidly confined to the male sex is difficult to explain by supposing it to be due to food-smells or other attractive smells emitted by plants or flowers, unless indeed we suppose that the males thus find out the eugenol-derivative-producing plants where the females are likely to be. It is noteworthy that the males are not ordinarily seen at other flowers. In order to explain the absence of females on the Papaya, Cycad, and *Colocasia*, we should then have to suppose that since females are never seen at these plants they must either (1) have food-tastes quite distinct from those of the males, or (2) must have an entirely different method of finding their resting-places.

I am impressed with the fact that in individuals of opposite sexes of the same species we have often to deal with two almost totally distinct personalities, if we may use the term. Nevertheless, and granting this in the case particularly of blood-sucking insects such as CULICIDAE, in which there is a marked difference in feeding-habits, it somehow seems on the face of it unlikely that in fruit-flies we should find differences sufficiently marked as to justify either of the above explanations. The facts observed might be, on the other hand, simply and easily explained by a hypothesis that the smells have some definite sexual significance. It is true that young crushed females did not attract males, but although the evidence with regard to the smell of the female is invalidated, I think it may be fairly confidently asserted that a very faintly discernible aromatic smell does actually exist. Recent experience with very weak odours has, however, shown me that it is well to exercise caution in forming conclusions as to their exact nature, the character of the smell often changing in a quite unexpected degree with an increase in strength, and I would not press this point.

The attraction of *Ceratitis capitata* by kerosene is now known to be similarly confined to the males and is apparently a quite analogous case. It seems at present to supply another argument for some directly sexual explanation of the phenomena.

In my former paper on this subject I wrote as follows :—" . . . . we might look on each species as tuned to respond to three or four notes on the scale of smell, and we should expect to find the most delicate adjustment and most accurate 'tuning' in the direction of the sexual smell, since errors of perception would here be most disadvantageous to the species. There would be a correlation between the degree of specialisation of the larva in the matter of diet and the definiteness of the smell which would prompt the female to lay eggs. In many cases the food-smell of the adult fly would be least narrowly adjusted. At all times other senses such as those of sight and touch might play a more or less important part as auxiliaries or controls.

" If we accept for the moment some such view as this, then among those species in which the male finds the female by smell we must regard each one as an assemblage of individuals in which one sex is tuned to respond to a certain definite kind of molecular vibration corresponding to some compound or mixture of compounds emitted by the other sex, and these compounds would thus constitute definite specific characters. We might even perhaps go further and define some of the larger groups by those 'generic' smells which characterise certain kinds of chemical substances, ... and which depend on the presence of certain atoms or of atomic groups of some particular configuration."

In the course of the investigation of which particulars have just been given, I made two observations which in the light of the latter part of the passage quoted are of interest.

The species of *Dacus* found at Pusa are *diversus*, *ferrugineus*, *zonatus*, *cucurbitae* and *caudatus*. The form hitherto known as *ferrugineus* var. *mangiferae*, Cotes, is, as Prof. Bezzi suspects, not a "true" variety, but merely a poorly-developed individual ; by giving insufficient or improper food it is quite easy to rear "*mangiferae*." I may also confirm here Prof. Bezzi's suspicion that the Australian *D. tryoni* may be identical with our *D. zonatus*. An examination of good specimens

of both (the *tryoni* I owe to the kindness of Mr. Froggatt) reveals nothing that can be called a specific difference, and I think there is little doubt that the name *tryoni* should rank as a synonym, and that methyl eugenol will be found to attract the flies.

We have then at Pusa five species, whose life-histories show some diversity. The larvae of *zonatus* feed on fruits, particularly on peach, mango and guava; those of *ferrugineus* mainly on the fruits of Solanaceae, and on mango; those of *diversus* on the anthers of male flowers of Cucurbitaceae; and those of *cucurbitae* and *caudatus* on the flesh of Cucurbitaceous fruits.

Of these five species, my earlier experiments gave information regarding the substances attractive to *diversus*, *ferrugineus* and *zonatus*, but none respecting *cucurbitae* and *caudatus*. The fact that the preferences of *diversus* and *zonatus* for iso- and methyl-eugenol respectively were clearly differentiated, encouraged me to hope that it might be possible ultimately to unravel the chemical relations of all five species. The question of the relationship between *zonatus* and *ferrugineus* is one which I do not attempt to deal with at present, but it seems to be much closer than that between *zonatus* and *diversus*. The morphological and general "bionomic" evidence is so far in agreement with the close connection revealed by the chemical experiments. I refer again to this point later on.

In the hope of attracting *cucurbitae* and *caudatus* I tried a variety of substances and mixtures. Among these were :—

(1) A solution of vanillin in hot amyl alcohol, mixed with water and exposed for several days in a bowl;

(2) a solution of vanillin in amyl alcohol, warmed with hydrogen peroxide and exposed in water.

In both cases a wine-purple solution is obtained; in (1) the colour appears after a day or two, in (2) it develops in a few minutes. At the time when these solutions were being exposed (March), *caudatus* was known to be breeding in a patch of gourds in the kitchen-garden a quarter of a mile away, but it was very scarce, only one fruit containing larvae being discovered. In the course of a fortnight, four male *caudatus* were found drowned in the amyl-vanillin solution, three in No. 1 and one in No. 2. One of these was observed (in No. 1) when it settled, and its behaviour was quite similar to that exhibited by *zonatus* and *diversus* under like conditions. When a single fly of either of these species settles in a bowl, it soon becomes curiously fearless; as one of my assistants correctly phrased it, "they pay no attention to threats." The same thing was noticeable with the *caudatus*. The amyl-vanillin solutions were exposed on the same table as the eugenol derivatives which were attracting other species, but no *caudatus* were found in or on these bowls, while the amyl-vanillin had no observed attraction for any species but *caudatus*. No *caudatus* were caught by solutions of amyl alcohol in water, or by vanillin in dilute ethyl alcohol, but the short *caudatus* season was very possibly over when these were exposed.

The nature of the chemical substance here involved is unknown; it may be an oxidation-product of vanillin. The vanilla-like smell (suspected to be sexual) emitted by certain male Lepidoptera might be taken to point vaguely to possible analogies between the two groups in the matter of chemico-sexual relations. I have alluded already to the sharp difference between the remarkable attractiveness of iso-eugenol

for *diversus* and the unattractiveness of fresh solutions of the isomeric substance eugenol. Working on the hypothesis of the existence of generic "smell-groups," and bearing in mind the comparative ease with which iso-eugenol is obtained from eugenol, it seemed to me that there might very probably be some species whose males are attracted by eugenol. Similar considerations had already resulted in the case of *caudatus* being brought perhaps more or less into line with the others, but there remained of the known Pusa species only the very common *cucurbitae*, which was not attracted by eugenol or any of the other substances used. The DACINAE of Pusa have for the last three years been observed with some care, and the chance of finding a new eugenol-attracted form seemed slight. Nevertheless, I continued to expose eugenol, and on the 27th of July was rewarded by the capture of a single specimen of the male of an entirely fresh species (fig. 6, Pl. xiii.). This individual was seen by me to settle in the bowl; like *caudatus*, it exhibited the characteristic beglamoured behaviour and had all the appearance of having found its own particular "bait." It is probably the first victim of deliberate chemical collecting.

The investigation here described was undertaken with the idea of ascertaining whether or no the smell-reactions were specifically differentiated. A definite specific differentiation appears to be proved in the case of *diversus* and eugenol, *zonatus* and methyl-eugenol, and possibly *caudatus* and amyl-vanillin and *Dacus* sp. and eugenol. Between *zonatus* and *ferrugineus* I have been unable to draw any sharp line. There seem to be differences combined with a general similarity. This may be due to the fact that my analysis of the chemical relations is not carried far enough to differentiate the compounds attractive to these two forms respectively. The *ferrugineus* compound, if ultimately separated, will certainly be found to be closely similar to methyl- and iso-eugenol. I have made some study of the relations of these two species from other points of view, and it seems to me a fact of some interest that this study reveals a state of affairs apparently in agreement with that which is chemically indicated. In spite of the frequent difference in larval feeding-habits, there exists among adult males a complete series of forms intermediate in colour and pattern between those shown in fig. 1 and fig. 3, Pl. xiii., and there are other evidences of close physiological connection.

We seem to be dealing in the case of these five species of *Dacus* with a group of insects particularly susceptible to a group of smells (allyl- or propenyl-phenols (?)), each species being specially reactive to one member of the group, the degree to which this reactivity or receptivity is specialised appearing to correspond to the degree of morphological and physiological differentiation of the insect as shown in other directions. The precise degree of specialisation can only be discovered by more controlled and detailed chemical investigation than has hitherto been possible. As the evidence regarding the smell of the females has proved unreliable I have thought it better to publish the results obtained up to the present, in order that other interpretations of these curious reactions of male *Dacus* and *Ceratitis* may be given due weight.

Summary.

There are certain smells remarkably attractive to male flies of the genus *Dacus* and by the employment of these smells the movements of the flies can to a great extent be controlled in any given direction. The reaction is strictly

confined to the male sex, and different species exhibit a variation as regards the smell which is most attractive to them. It is uncertain whether the females emit similar smells; on the whole improbable.

Three of the commoner species of the flies (*D. diversus*, *ferrugineus* and *zonatus*) normally breed respectively in (1) anthers of Cucurbitaceae, (2) fruits of Solanaceae and mango, and (3) peach, guava, mango and other fruits. *D. diversus* (1) is most strongly attracted by iso-eugenol, *zonatus* (3) by methyl-eugenol, and *ferrugineus* (2) by both methyl and iso-eugenol. The smells of these substances have not yet been identified with those of the plants which constitute the normal breeding-places, but male flies have been found attracted to mango, Papaya, a Cycad, and *Colocasia*. plants with a very characteristic smell similar to that of eugenol-derivatives. Females have never been seen to frequent these plants or to breed in them, but more extended observation is required on this point before it can be definitely said that they never do so. The males give the impression that they might visit these plants for food, for they suck the surface of the flowers, though they do not seem to exhibit any very particular avidity. One species (*ferrugineus?*) has been bred from a *Eugenia* at Bangalore.

Three explanations suggest themselves:—

(*a*) The smell is a direct sexual guiding smell emitted by the female.

But young crushed females did not attract males.

(*b*) The smell is not emitted by the female, but may be termed an "indirect" sexual guide to the plants where the females are accustomed to congregate for breeding purposes.

Under these circumstances it is difficult to see why females should not also be attracted by the odoriferous chemicals.

(*c*) The smell is a food-smell.

It must then be a food attractive only to males.

Two other species of fruit-flies, *D. caudatus* (breeding in fruits of Cucurbitaceae) and an unidentified species, were captured by means of an amyl-vanillin solution and of eugenol respectively. The rarity of the flies and the small numbers caught (four and one) make it advisable, however, to postpone detailed comment on these two cases, and future work may give more definite information as to their chemical relations. No substance attractive to male *cucurbitae* has been found.

All the observations described were made at the Pusa Research Institute, India.

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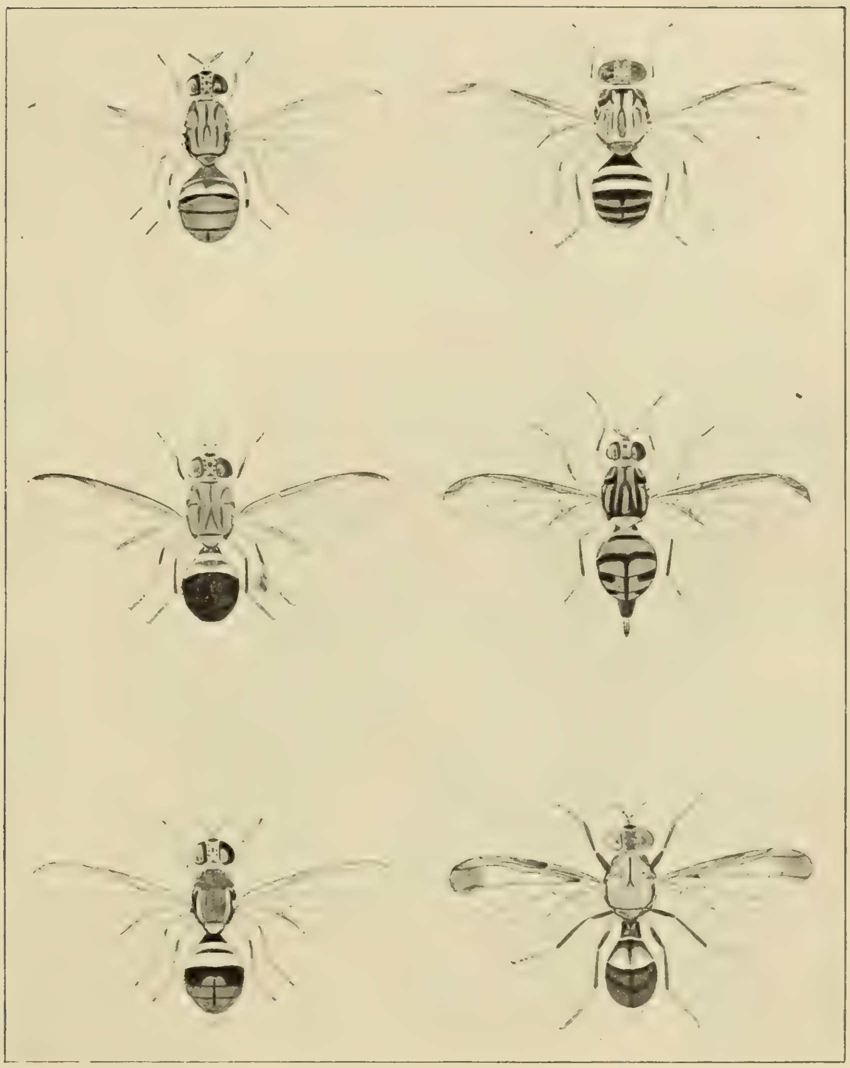

2 5

3 6

Fig. 1. *Dacus zonatus* ♂

Fig. 2. Form intermediate between (1) and (3).

Fig. 3. *Dacus ferrugineus* ♂

Fig. 4. *Dacus diversus* ♂

Fig. 5. *Dacus cucurbitae* ♀

Fig. 6. *Dacus* sp. ♂

This plate is from a photograph of a water colour drawing, and the tones on the thorax and abdomen are therefore not quite accurate.

Fig. 1. Males of *Dacus zonatus* at a bowl containing 0.5 c.c. of methyl eugenol in a pint of water, after one hour's exposure from 8 a.m.

Fig. 2. Males of *Dacus diversus* at a bowl containing 0.5 c.c. of isoeugenol in a pint of water, after one hour's exposure from 8 a.m.

Explanation of Plate XV.

Fig. 1. Down the left-hand side of the vertical strip of paper the cork from a tube of methyl eugenol has been rubbed, so as to leave a smear, and there is a small circular patch of methyl eugenol made in the same way at the bottom right-hand corner of the paper strip. To the right of this there is a similar streak of isoeugenol, and on the extreme right a streak of eugenol. The flies are practically all *Dacus zonatus* (there were two *D. diversus* on the middle streak), and approached up-wind from the right of the picture.

2. The same surface (a cork mat) a week afterwards.

Fig. 1.

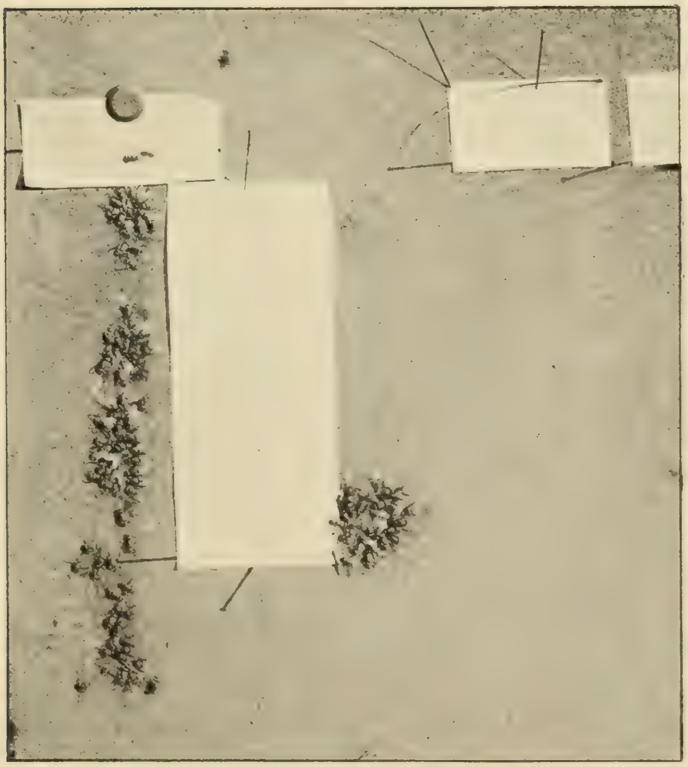

Fig. 2.

Experiments on the attraction of *Dacus* by eugenol derivatives.

Explanation of Plate XVI.

Fig. 1. To show the fearlessness of the flies. Male *Dacus zonatus* on fingers very slightly smeared with methyl eugenol.

2. Male *Dacus* at methyl eugenol, eugenol, isoeugenol, and "methylate of isoeugenol" (labelled methyl-isoeugenol). Small drops of the substances were placed on paper. Practically all the flies were typical *D. zonatus*, but at the left-hand drop of isoeugenol there was one *D. diversus* and one intermediate *D. zonatus-ferrugineus*. The neglect of the eugenol and isoeugenol by *D. zonatus* is very marked.

Fig. 1.

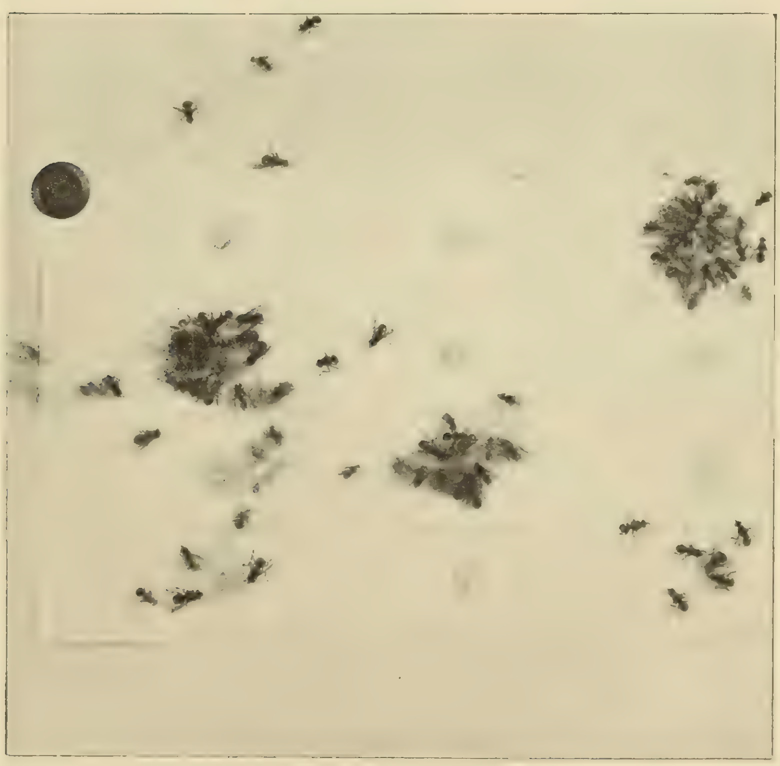

Fig. 2.

Experiments on the attraction of *Dacus* by eugenol derivatives.

OOENCYRTUS PACIFICUS, A NEW EGG PARASITE FROM FIJI (HYM.).

By JAMES WATERSTON, B.D., B.Sc.,

Imperial Bureau of Entomology.

Ooencyrtus pacificus, sp. nov. (fig. 1).

♀.—Head and body shining black, with slight metallic reflections as follows:—Genae dark green, purplish and carmine towards the eye; upper surface of abdomen, in some lights, very faint dark green; tegulae like the rest of the thorax. Antennae dark brown, almost black on scape, pedicel and base of funicle; last two funicular joints lighter; club entirely pale. Wings almost hyaline, but with a faint tinge of yellow, and slightly browned on the submarginal towards the costa, as well as on the punctiform marginal vein. Legs entirely pale yellowish; the posterior femora a little browner on the dorsal edge towards the apex.

Head (fig. 1, *b*) just broader than deep (15 : 14). Eyes bare; closely approximated on the vertex, where they are separated by less than the diameter of either, or by rather more than one-fourth of the greatest breadth of the head, but with orbits so widely divergent that the lowermost angles are three times as far apart. Lateral ocelli nearly touching the eyes; not farther from the margin than one-half the diameter of an ocellus. Scrobes set well below the base line of the eyes; elongate, triangular, with rounded angles, wide apart, each of the opposed edges aligned with a lateral ocellus and the corner of the mouth-opening; the lower angle of the scrobe is halfway between the upper angle and the mouth-edge. Clypeal edge occupied by three equal, flatly rounded lobes. Occiput, vertex and frons to about the middle finely reticulate, the pattern so little raised that the surface is shining. Below one-half at the sides and towards the genae the pattern is more flowing and striate, while the mid area above and between the scrobes is perfectly smooth; there are one or two faint wrinkles above the middle of the mouth-edge; on the genae the pattern is distinctly raised in ridges, but the surface is hardly duller. On the vertex posteriorly are about four short bristles (one behind each ocellus and two between); below the anterior ocellus a bristle on each side. There are nine to ten short fine orbital bristles, the last four or five being double. Above the mouth-edge are four bristles (2,2) and on the intra-scapal area are two vertical rows (3–4, 3–4), above which are a final pair, somewhat inwardly displaced. The malar space in front of the ridge is nearly bare, but there are several bristles on the genae.

Antennae twelve-jointed: scape, pedicel, ring joint, six funicular, and five in the club. The club is not so strongly chitinized as the remainder of the antennae. Scape (7 : 2) with a subdorsal row of five bristles outside and two rows (5, 5) on the inner aspect, besides 8–9 dorsal bristles. Pedicel long and narrow (3 : 1), about three-sevenths of the scape. Ring joint, a minute lamina with a distinct stalk of insertion. Funicle gradually expanded, the first three and the last three joints, respectively, subequal; the first joint one-third of the pedicel, or five-ninths of the last funicular joint; the first three funicular joints subquadrate; the last joint nearly quadrate (9 : 8) and much broader (8 : 5) than the first. Club (10 : 9 : 8) twice as wide as the first, or about one-third wider than the last funicular joint.

The first three funicular joints bear a single row of rather stout stiff bristles, and the last three bear two such rows ; on the club the bristles are more numerous and hyaline. There are few sensoria, and none till the fourth joint of the funicle, which, like the fifth, bears 1–2 ; the sixth bears 3 ; in the club the arrangement is 4, 3–4, 2. Length of antenna, ·55 mm. *Mouth-parts :* maxillary palpus, 10, 7, 6, 8 ; first and fourth joint of the same breadth ; second and third broader. One hair on the first ; two on the third, four on the fourth ; labial palpus, 8 : 5 : 3 ; four hairs on the third. Mandibles with two minute approximated apical teeth ; the inner edge of the mandible broadly rounded.

Thorax.—Pronotum cut away obliquely, but almost without emargination above the spiracle ; pattern moderately fine. An anterior irregular row (3, 3) and another posterior (7, 7) of stouter bristles, with a similar row of much finer bristles just in front. *Mesonotum* coarsely reticulate, raised, especially in front ; with about forty bristles (20, 20). Axillae with pattern fainter and 4–6 bristles Scutellum smooth, without indication of pattern save near the suture ; about sixteen bristles and two clear pustules. Mesopleurae bare, with extremely fine striate pattern, not raised ; mesosternum smooth, except along the middle line, where a regular, rather coarse reticulation is developed.

Wings.—Fore wings less than three times as long as broad ; in general shape slightly spatulate, and narrow on the basal half. The neuration does not reach beyond the middle of the costa. The submarginal vein (bearing twelve bristles) is basally broad, medianly narrowed, subapically swollen again below, and contracts a little before reaching the costa. The marginal (with three or four larger bristles and a few shorter) is very short and broad, while the postmarginal is rudimentary. The radius, medianly narrow, is almost bare, but in front, the bristles of the membrane come up to the vein, one or two being set at the edge ; behind there is a narrow bare area. The subcostal cell is long and narrow, with numerous minute hairs on the proximal half, and 6–8 much stronger ones apically. From behind the radius, a hairless line stretches to the middle of the posterior edge. In front of this line the wing is evenly ciliated and at one-third from the radius, on the anterior edge, are three short, flattened, strong bristles. The basal triangle of the wing is also evenly ciliated, but the hairs are longer, weaker and more scattered. Submarginal : marginal : radius : postmarginal—30 : 3 : 6 : 1. Length, ·85 mm. ; breadth, 30 mm. *Hind wings* evenly ciliated ; cilia of basal half much shorter ; submarginal cell practically absent. Submarginal (bare) : marginal (8–9 bristles)—5 : 6. Length, ·60 mm. ; breadth, ·15 mm. *Legs.—Fore legs :* coxae oblong (10 : 7), a little narrower apically than at the base, with, externally, 4–5 transverse rows of bristles containing four each ; on the inside 4–5 bristles along the anterior edge, and one to two above the insertion of the trochanter. Femur anteriorly broadly bare medianly from base to apex, with only six to seven weak, short bristles in a subventral row, and about two rows (8–10) of similar bristles below the dorsal edge ; three stouter and longer subapical ventral bristles. Tibia very slightly expanded ; apical comb of seven spines, with two on posterior edge ; comb of first tarsal joint of twelve spines. Proportions of the tarsal joints :—22 : 15 : 14 : 13 : 20 (with claw). *Mid legs :* coxa similar to that of the fore leg, but with more bristles outside. Tibia expanded from a half onwards ; nearly three times broader at the apex than at the

base ; three to four short peg-like apical spines anteriorly. Spur not longer than the first tarsal joint which bears about thirteen heavy spines arranged as follows :—three antero-apically, four to five on the plantar aspect and the remainder on the posterior edge ; joints 2, 3, 4, with six, five and four spines, respectively. The tarsal proportions are 40 : 18 : 15 : 14 : 25. *Hind legs :* coxa quadrate, reticulate outside on apical ventral half, where there are a few bristles. Tibia with three to four spines posteriorly and subapically and ten to eleven in a transverse apical comb ; the spur fine-pointed and short, and about half as long as the first tarsal joint. Proportions of the tarsal joints as in the mid legs, but the first joint one-fourth shorter.

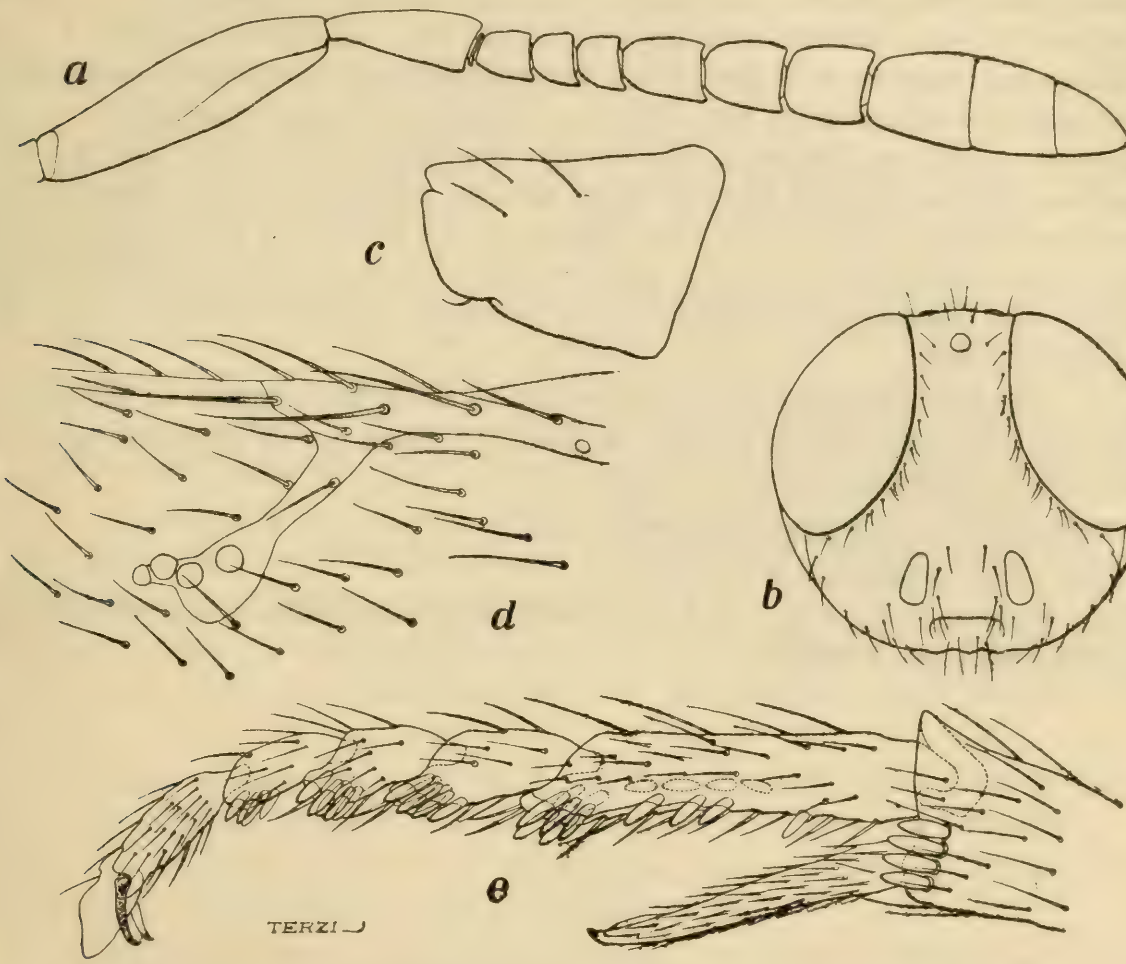

Fig. 1. *Ooencyrtus pacificus* Waterston, sp. n., ♀ ; *a*, antenna ; *b*, head ; *c*, mandible ; *d*, marginal vien and radius of fore wing ; *e*, mid-tarsus.

Propodeon deeply excavated to receive the abdomen ; almost separated into two smooth triangular sclerites above. The pleurae likewise smooth, but with transverse rugae indicated ventrally. The small, oval spiracle lies anteriorly in the extreme angle between notum and pleurae, with three to four bristles.

Abdomen.—The dorsal surface smooth and bare, except near the extreme apex. The overlaps of the tergites bear two to four bristles ; the U-shaped seventh tergite bears anteriorly 3, 3 and 2, 2 bristles ; there are also median, post-median and posterior rows of about 5, 5, 4 bristles, respectively. The nearly circular spiracle has one bristle in front, one behind, and one on each side. The ventral surface bears

all over numerous short bristles from the second sternite onwards, and there are two patches besides, on sternite 5 ; on the same sternite the four posterior bristles (2, 2) are stouter and longer. Ovipositor with the articulated portion of the sheath short and broad, about one-fifth of the base ; the apex of the sting finely and very shortly serrate.

Length, ·7 mm. ; alar expanse, about 2 mm.

♂.—Similar to the ♀ ; the metallic green on the genae more pronounced. Antennae with scape blackish brown, and the remainder fuscous ; paler towards the tip, but with no such contrast between club and funicle as in the ♀. Hind femora infuscated.

Head.—The eyes are wider apart on the vertex, and the lateral ocellus separated by at least its own diameter from the edge of the eye. *Antennae :* length, ·7 mm. ; the joints are the same as in the ♀, but the segmentation of the club is obliterated. Scape rather broader than in the ♀ (3 : 1). Pedicel short and broad (5 : 3) ; funicle cylindrical, joints in the ratio, 11 : 12 : 14 : 16 : 15 : 15. The club (in the same proportion, 60) is one-half broader than the last funicular joint. The funicular joints bear tubular hairs, of which the longest do not exceed the joint on which they stand ; these hairs run as far as the middle of the club, those on the distal half being shorter. The sensoria of the funicle are as in the ♀, but there are only one or two in all on the club.

Legs.—The first mid tarsal joint is shorter, with fewer heavy spines on this and the succeeding joints (4–5 less in the case of joint 1) ; there is only one such spine also at the apex of the tibia, before the spur.

Length, ·7 mm. ; alar expanse, about 2 mm.

Type.—A ♀, in the British Museum.

Fiji : Rarawai, Viti Levu. 1 ♂, 2 ♀♀, bred from eggs of the Bean Bug (*Brachyplatys pacificus*, Dall.) (*R. Veitch*).

COLLECTIONS RECEIVED.

The thanks of the Imperial Bureau of Entomology are due to the following gentlemen, who have kindly presented collections of insects (received between 1st April and 30th June, 1915) :—

Dr. W. M. Aders :—111 Mosquitos, 1 other Dipteron, and 4 Coleoptera ; from Zanzibar.

Mr. E. Ballard, Government Entomologist : —33 Moths (*Phthorimaea heliopa*) ; from Coimbatore, South India.

Mr. W. P. B. Beal, Veterinary Officer : —75 *Tabanus*, and 27 *Glossina* ; from Ashanti.

Mr. G. E. Bodkin, Government Economic Biologist : – 29 Culicidae, 12 other Diptera, about 130 Ants, 254 other Hymenoptera, 68 Coleoptera, 1 Butterfly, 3 species of Coccidae, 14 other Rhynchota, 10 tubes of Mallophaga, 31 Orthoptera, 15 Ticks, 2 tubes of Sarcoptid mites, 18 other Arachnida, and 1 Millipede ; from British Guiana.

Mr. E. C. Chubb, Curator of the Durban Museum :—130 Culicidae 21 *Tabanus*, 6 *Glossina*, 3 *Stomoxys*, 4 *Lyperosia*, 5 *Auchmeromyia*, 1 Nycteribiid 3 Streblidae, 5 other Diptera, and 93 Rhynchota ; from Natal.

Dr. J. Burton Cleland, Principal Microbiologist :—28 Culicidae, 40 Tabanidae, 49 Muscidae, 15 Tachinidae, and 9 Hippoboscidae ; from Australia.

Dr. J. B. Davey, M.O. :—1 Mosquito, 1 *Chrysops*, 58 *Haematopota*, 17 *Tabanus*, 21 *Glossina*, 1 *Stomoxys*, 1 *Auchmeromyia*, 7 other Diptera, 1 Beetle, 2 Rhynchota, 1 Orthopteron, and 1 Spider ; from Nyasaland.

Mr. d'Emmerez de Charmoy, Government Entomologist :—2 Ichneumonidae, 8 Braconidae, and 28 Chalcididae parasitic on *Diatraea* and *Sesamia* ; from Mauritius.

The Division of Entomology, Pretoria :—6 Diptera, 12 Hymenoptera, 55 Coleoptera, 16 Lepidoptera, 87 Rhynchota, and 36 Orthoptera ; from the Transvaal.

Dr. R. E. Drake-Brockman :—28 *Phlebotomus*, 24 other Diptera, 8 Fleas, about 200 Anoplura, and 400 Ticks ; from British Somaliland.

Mr. Gerald F. Hill, Government Entomologist :—5 Culicidae, 18 *Tabanus*, 4 other Diptera, 3 Hymenoptera, 19 Coleoptera, including 2 co-types of *Polyphrades collaris*, Lea, and 1 of *P. basirostris*, Lea, 20 Lepidoptera, including 3 co-types of *Nephogenes stibaropae*, Turner, and 2 of *Anthela ochroneura*, Turner, and 12 Orthoptera ; from the Northern Territory, Australia.

Mr. Rupert W. Jack, Government Entomologist : —15 Bees and 21 Moths ; from Salisbury, Southern Rhodesia.

Dr. W. A. Lamborn : —13 *Pangonia*, 6 *Haematopota*, 32 *Tabanus*, 1 *Auchmeromyia*, 116 puparia and a large number of imagines of *Glossina morsitans*. 12 Asilids with their prey, 181 other Diptera, 111 Hymenoptera and their prey, 601 other Hymenoptera, 64 Lepidoptera, 122 Coleoptera, 1 Ant-lion, 1 Coccid, 9 other Rhynchota, 116 Odonata, and 8 Orthoptera ; from Nyasaland.

Dr. J. W. Scott Macfie, W.A.M.S. :—98 Culicidae, 1 *Phlebotomus*, 1 *Tabanus*, 6 *Glossina*, 1 *Stomoxys*, 1 *Cordylobia*, 11 other Diptera, and 4 Hymenoptera ; from the Gold Coast.

Dr. A. MacRae :—32 Culicidae, 1 *Tabanus*, 4 Streblidae, 9 other Diptera, and a large number of *Anthrenus* larvae ; from Aden.

Professor F. Silvestri :—2 co-types of the Chalcid *Tetrastichus giffardii*, Silv.

Dr. A. T. Stanton, Government Bacteriologist :—73 Culicidae, and 1 Cicada ; from Siam.

Dr. H. Swale :—11 *Dorcaloemus*, 1 *Pangonia*, 1 *Tabanus*, 1 *Auchmeromyia*, 2 larvae of *Cordylobia*, 4 other Diptera, 17 Hymenoptera, 50 Termites, and 1 Spider ; from Southern Rhodesia.

Mr. F. W. Urich, Government Entomologist :—15 Coleoptera ; from Trinidad.

Mr. P. van der Goot, Government Entomologist :—4 Locusts ; from Java.

Mr. Robert Veitch :—12 Diptera, 1 Hymenopteron, 2 Lepidoptera, 26 Coleoptera, 1 Ant-lion, 1 sp. of Coccidae, 3 other Rhynchota and 4 Odonata ; from Fiji.

Wellcome Bureau of Scientific Research :—6 *Pangonia* ; from Bogota.

Mr. Rodney C. Wood :—5 Culicidae, 2 *Pangonia*, 1 *Cadicera*, 16 *Dorcaloemus*, 2 *Thriambeutes*, 38 *Haematopota*, 139 *Tabanus*, 1 *Cordylobia*, 1 Bombyliid, 26 Coleoptera, and 1 Reduviid bug ; from Nyasaland.

VOL. VI. Part 4.—pp. 313-426. FEBRUARY, 1916.

BULLETIN OF ENTOMOLOGICAL RESEARCH

ISSUED BY THE IMPERIAL
BUREAU OF ENTOMOLOGY.

EDITOR: THE DIRECTOR.

LONDON:
SOLD BY
DULAU & Co., Ltd., 37, SOHO SQUARE, W.
Price 4s. net.

IMPERIAL BUREAU OF ENTOMOLOGY.

HONORARY COMMITTEE OF MANAGEMENT.

TICKS OF THE BELGIAN CONGO AND THE DISEASES THEY CONVEY.*

By George H. F. Nuttall, M.D., Ph.D., Sc.D., F.R.S.,

Quick Professor of Biology in the University of Cambridge, in consultation with
C. Warburton, M.A., F.Z.S.

(With 48 Text-figures.)

Contents.

Introduction.

The subject of ticks and the diseases they convey is one of great practical importance to agriculturists and pathologists in such a country as the Congo. Of the species recorded from the Congo, one conveys relapsing fever to man and eight have been shown to convey diseases to domesticated animals in various parts of Africa.

In the following pages a short resumé is given of the classification of ticks. From practical considerations of space and in the hope that this paper will prove useful particularly to workers in the Congo, a technical and lengthy description of the different species has been purposely omitted. Since we are only dealing with ticks at present known to occur in the Congo—some 29 species—it will suffice if we give a few of the main characters whereby these species can be distinguished. In this connection we rely largely on illustrations which amplify the descriptions sufficiently for the rapid determination of some of the commoner species. On the other hand, it must always be remembered that to determine the species to which a tick belongs is frequently a matter of considerable difficulty even to the expert. Some species are easily recognised with the naked eye, others require careful examination under the microscope. In the latter case they are best studied as opaque objects laid upon a small cone of modelling wax which can be moved about so as to give the specimen the desired orientation. A binocular microscope is almost essential, combined with good illumination.

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* Written at the request of the Belgian Authorities.

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The best way for the beginner to start the study of ticks is to collect specimens and to submit them to a specialist for determination ; he will save much time by so doing. When the specimens are returned they will serve as standards for comparison with any other specimens which may be collected.

The subject of the biology of ticks, especially that of the species occurring in the Congo, is fully dealt with and a short account is given of the diseases they convey.

Those desiring more detailed information on the subjects treated of in this paper are referred to *Ticks, a Monograph of the Ixodoidea*, by Nuttall, Warburton, Robinson and Cooper, Parts I, II, III, and the Bibliographies I and II accompanying this work ; also to *Parasitology*, Vols. I–VIII. Both publications are from the University Press, Cambridge.

Classification.

Ticks are Acarina belonging to the suborder METASTIGMATA, i.e., having their respiratory apertures (*stigma* or spiracle) situated somewhat posteriorly on the body. They possess a characteristic capitulum or false head (fig. 1) consisting of (*a*) basis capituli, bearing (*b*) paired palps, (*c*) paired chelicerae with digits having outwardly directed teeth, and (*d*) a ventrally toothed rigid hypostome. Ticks are blood-sucking parasites of mammals, birds, terrestrial reptiles and amphibia. Some species are only parasitic on birds, others on reptiles, others again may occur on mammals, birds and reptiles.

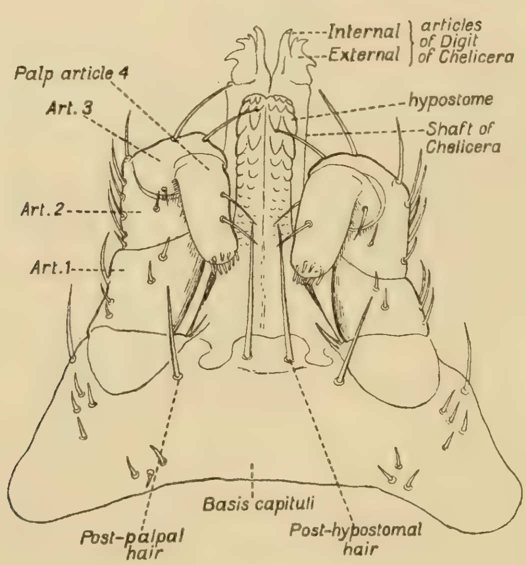


Fig. 1. *Argas persicus* (Oken 1818) ♂: capitulum in ventral aspect (Nuttall, 1908).

Ticks constitute a superfamily, IXODOIDEA, which contains two families, (1) ARGASIDAE and (2) IXODIDAE. The most striking difference between these two families (figs. 2 and 3) is the possession in IXODIDAE of a hard *scutum* or shield which covers the whole body of the male and the anterior part of the body in the female, nymph and larva. The ARGASIDAE have no such scutum, and the sexes are only

distinguishable by the shape of the sexual orifice. In ARGASIDAE the capitulum in adults and nymphs is covered by the overlapping body, in IXODIDAE it is terminal and visible dorsally.

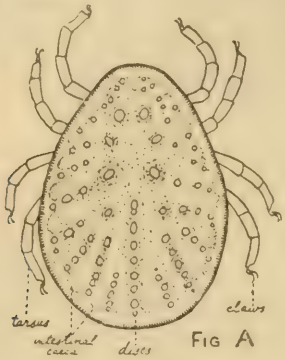


Fig. 2. Argasidae (*Argas*) (Nuttall and Warburton, 1908).

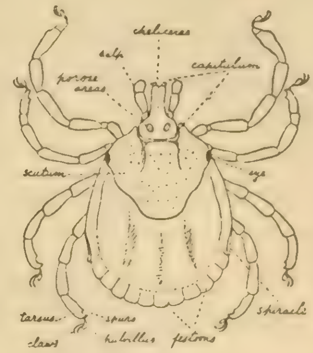


Fig. 3. Ixodidae (*Amblyomma* ♀) (Nuttall and Warburton, 1908).

At least four stages occur in the development of ticks : egg, larva, nymph and adult. In ARGASIDAE there may be two or more nymphal stages. The larvae in both families are hexapod, eight legs only appearing in the following or nymphal stage. The nymph resembles the adult (male and female in ARGASIDAE and the female in IXODIDAE) but for the absence of the sexual aperture and secondary sexual characters.

1. ARGASIDAE.

The ARGASIDAE comprise two genera : *Argas* and *Ornithodorus* and, as far as known to-day, are represented in the Belgian Congo by but one species *Ornithodorus moubata* (fig. 4), of which the adult usually measures about 8 mm. in length, but may attain a length of 12 mm. The colour is dusty brown or greenish when alive. The

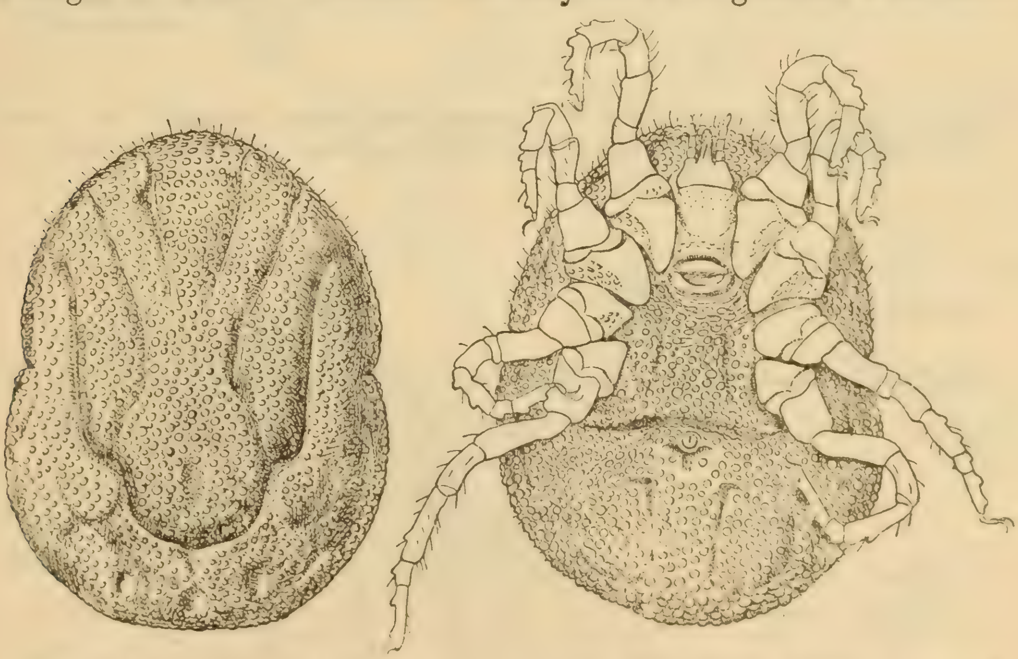


Fig. 4. *Ornithodorus moubata* (Murray, 1877) ♀: dorsal and ventral aspects (Nuttall, 1908).

integument has a granulated appearance and the legs bear characteristic humps. The species is eye-less. The largest nymphs resemble the adults. The first stage nymph, when unfed, measures usually but 1 mm. in length, and has a yellowish colour ; in appearance it recalls the adult. The species is important as the carrier of relapsing fever of man in tropical Africa. (See further on p. 342.)

2. IXODIDAE.

The Ixodidae comprise nine genera of which all but one (*Margaropus*) occur in the Belgian Congo. Before considering the differences in these genera we must dwell briefly upon the structure of an Ixodid tick (see figs. 5 and 6).

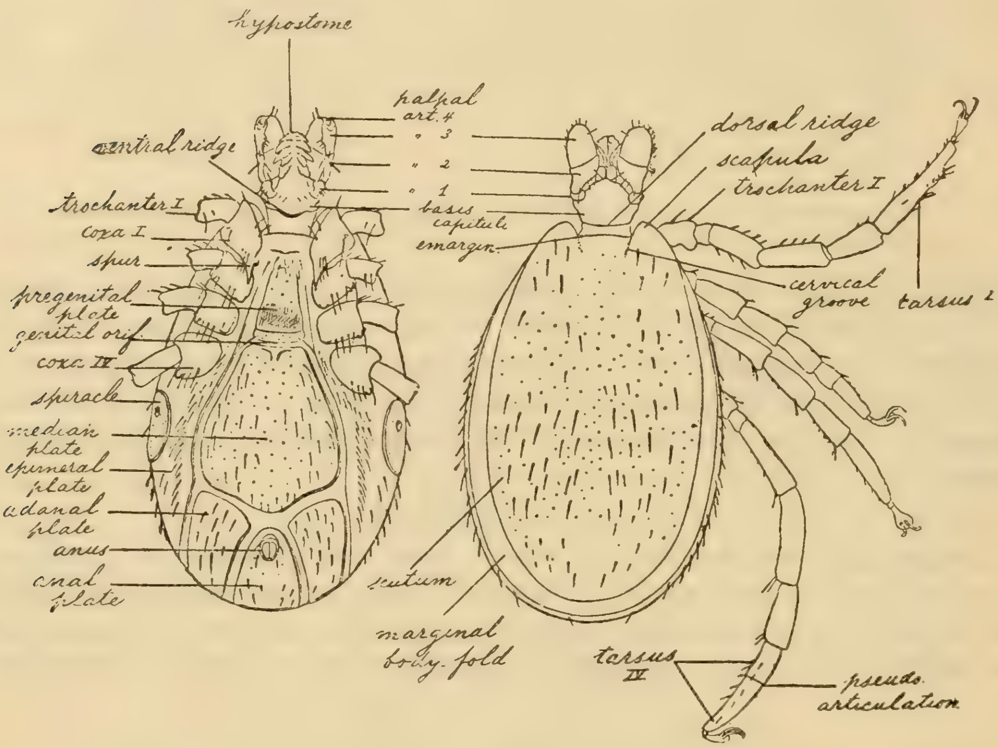


Fig. 5. *Ixodes ricinus* (Linn.) ♂: ventral and dorsal aspects. In Africa, the species only occurs along the Mediterranean. (Nuttall, 1908).

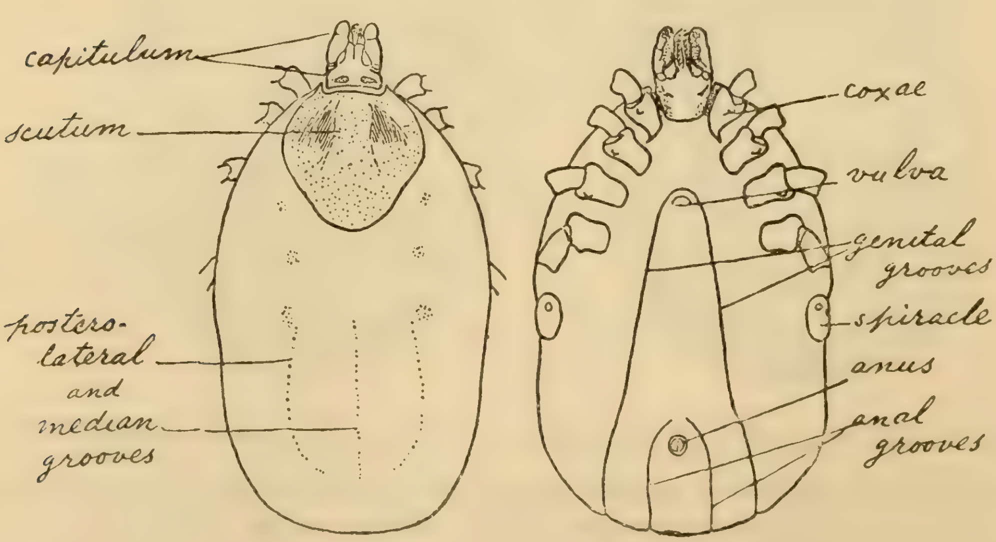
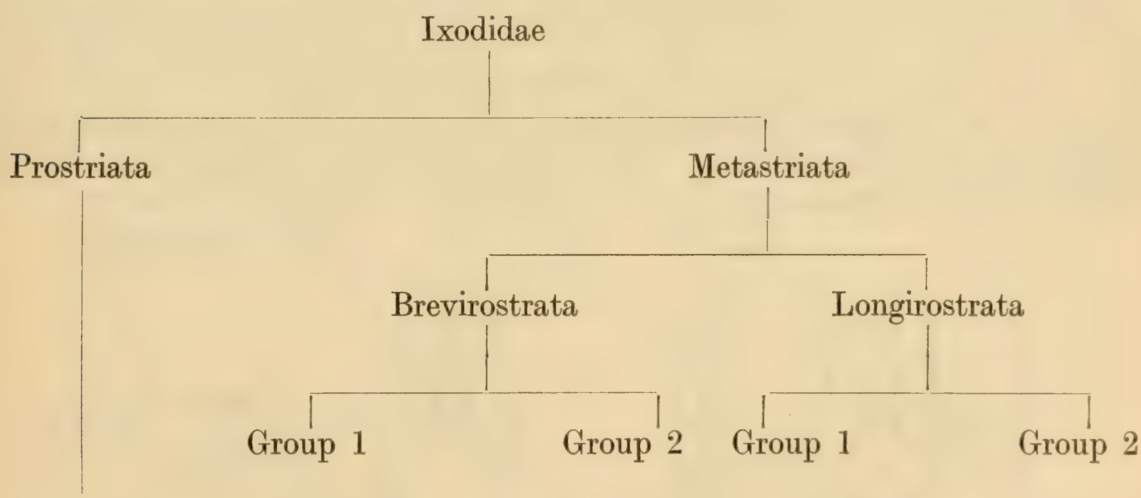


Fig. 6. *Ixodes hexagonus*, Leach, 1815; replete ♀: dorsal and ventral aspects. The species does not occur in Africa. (Nuttall, 1911).

The sexes are very distinct. In the male the dorsal surface of the body is covered by a hard scutum, whereas in the female the scutum only covers a part of the body. When the male feeds his body swells only slightly, when the female feeds her body swells to a great size owing to her integument being highly distensible. Upon the dorsal surface of the basis capituli note the two porose areas which characterize the females of all Ixodid ticks. The structural points to note in a description of a tick concern (1) the *scutum* : its size, shape, grooves, emargination, punctations and colour ; (2) the *capitulum* : the shape of the basis capituli, the form of the palps and the structure of the hypostome ; (3) the *ventral aspect* : position of the sexual orifice, anus, anal grooves, plates or shields, and spiracle ; (4) the *legs* : the structure of the coxae, trochanters, and tarsi.

The nine genera of IXODIDAE are *Ixodes*, *Haemaphysalis*, *Dermacentor*, *Rhipicentor*, *Rhipicephalus*, *Margaropus*, *Boophilus*, *Hyalomma* and *Amblyomma* (including the sub-genus *Aponomma*). Their degrees of affinity are indicated by the following scheme (Warburton) :—



1. *Ixodes*. 2. *Haemaphysalis*. 3. *Dermacentor*. 4. *Rhipicentor*. 5. *Rhipicephalus*. 6. *Margaropus*. 7. *Boophilus*. 8. *Hyalomma*. 9. *Amblyomma*. (Sub-genus *Aponomma*).

The IXODIDAE fall into two divisions, the PROSTRIATA and METASTRIATA, of which the first comprises but one genus, the second comprising the eight remaining genera. The terms Prostriata and Metastriata refer to the position of the *anal grooves* which in *Ixodes* surround the anus in front, whilst in other Ixodid ticks the grooves are either posterior to the anus or obsolete.

Prostriata.

Genus 1. Ixodes.

Generic characters: Anal grooves surrounding the anus in front, scutum without coloured design (inornate), eyes and festoons absent, spiracles round or oval. Sexual dimorphism pronounced in respect to the capitulum. Males with ventral surface of the body covered by hard non-salient plates.

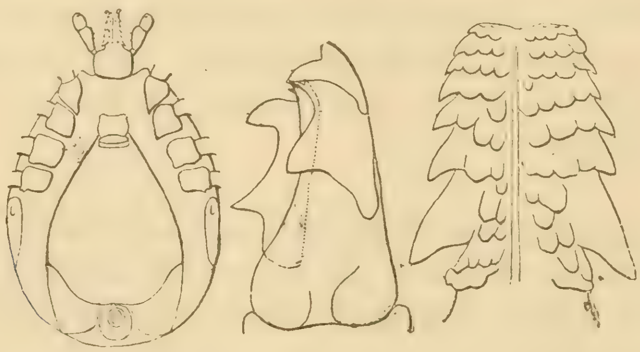


Fig. 7. *Ixodes rasus*, Neumann, 1899, ♂: ventral aspect; digit and hypostome highly magnified (Neumann, 1899).

This genus is poorly represented in Africa, and but two species have hitherto been recorded from the Congo: (1) *Ixodes rasus*, Neumann 1899, is unique among African *Ixodes* in possessing a small perfectly circular anal groove (figs. 7 and 8). (2) *Ixodes rubicundus* var. *limbatus*, Neumann 1908, ♂ unknown, the ♀ somewhat resembles *I. ricinus* (fig. 6) but the palps are longer and concave externally and coxae i., ii. and iii. bear no spurs. Recorded once from Katanga.

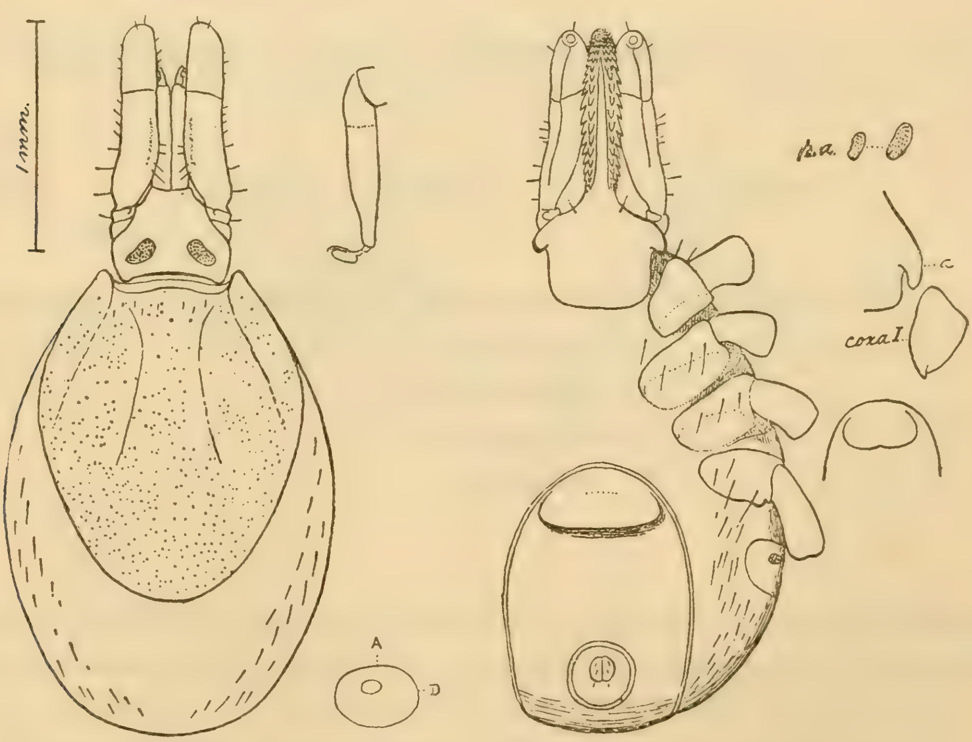


Fig. 8. *Ixodes rasus*, Neumann, 1899, ♀: dorsum, part of venter, spiracle and tarsus iv. (Nuttall, 1911).

Metastriata.

With festoons, and with anal grooves contouring the anus behind, except in *Boophilus* and *Margaropus*, wherein the festoons and anal grooves are absent.

(*a*) *BREVIROSTRATA.*

Group I.

Genus 2. Haemaphysalis.

Generic characters: Inornate, without eyes, festoons present, with usually short conical palps whose second articles project laterally beyond the basis capituli. With dorsal spur on the first trochanter. Usually of small size. Sexual dimorphism slight, the male shows no ventral plates or shields. Spiracles usually ovoid or short comma-shaped.

Two species of *Haemaphysalis* are recorded from the Congo :—

(1) *H. leachi* (Audouin, 1827) in which the palps protrude greatly at the sides in the adult and immature stages (figs. 9 and 10). For the biology of this species see p. 343.

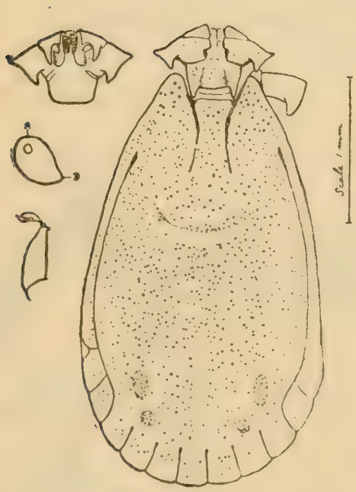


Fig. 9. *Haemaphysalis leachi* (Audouin, 1827) ♂: dorsum, capitulum in ventral aspect, spiracle and tarsus iv. (Nuttall, 1913).

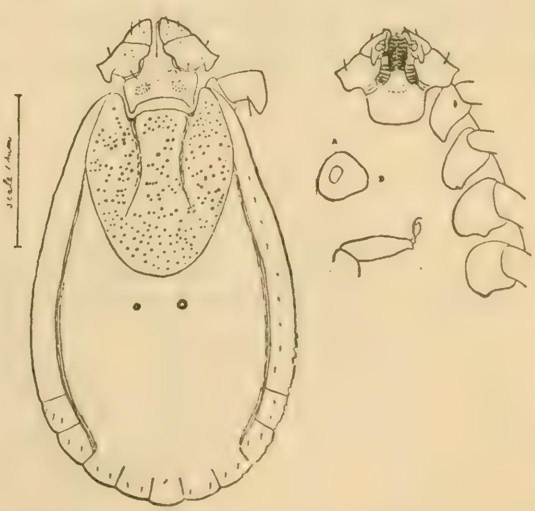


Fig. 10. *Haemaphysalis leachi* (Audouin, 1827) ♀: dorsum, part of venter, spiracle and tarsus iv. (Nuttall 1913).

(2) *H. parmata*, Neumann 1905, in which the palps protrude but slightly at the sides in the adult and immature stages (figs. 11 and 12).

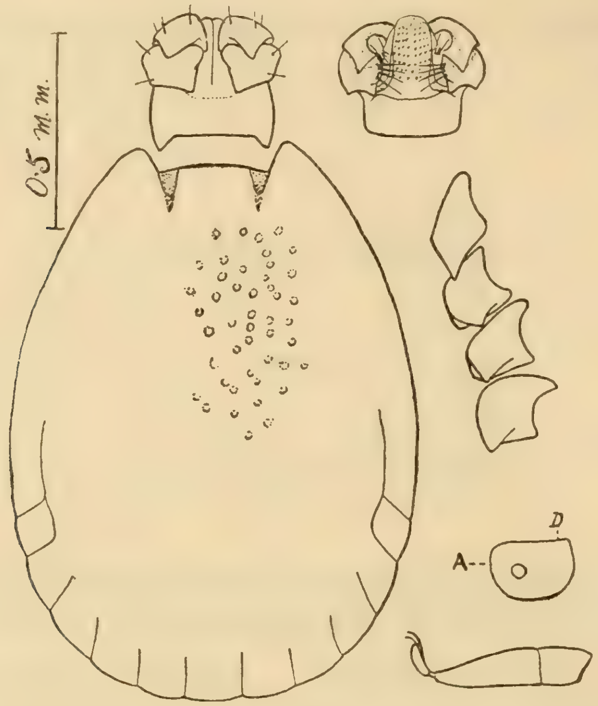


Fig. 11. *Haemaphysalis parmata*, Neumann, 1905, ♂: dorsum, capitulum in ventral aspect, coxae, spiracle and tarsus iv. (Nuttall and Warburton, 1915).

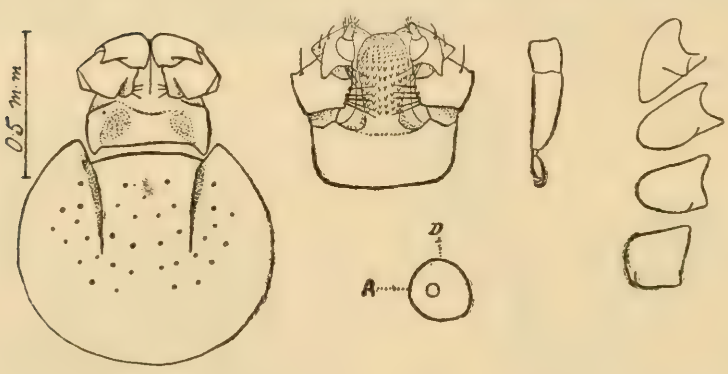


Fig. 12. *Haemaphysalis parmata*, Neumann, 1905, ♀: Scutum, capitulum in dorsal and ventral aspects, coxae, spiracle and tarsus iv. (Nuttall and Warburton, 1915).

Group II.

Genus 3. Dermacentor.

Generic characters: Usually ornate, with eyes and festoons, with short broad or moderate palps, basis capituli rectangular dorsally. Coxa IV. is much the largest. Male without ventral shields or plates. Coxa I. bifid in both sexes.*

* As in *Rhipicentor* (fig. 17).

Two species of *Dermacentor* are recorded from the Congo :—

(1) *D. circumguttatus*, Neumann, 1897. In the male the ornamentation consists of eight pale spots situated near the sides of the scutum. The female scutum bears three such spots (fig. 13).

Fig. 13. *Dermacentor circumguttatus*, Neumann, 1897 ; ♀ and ♂ scutums (Neumann, 1897).

(2) *D. rhinocerotis* (de Geer, 1778). In the male the ornamentation consists of large symmetrically disposed yellowish or brownish spots, one of which conforms to the shape of a female scutum, other smaller spots occupy the periphery and some of the festoons. In the female almost the entire scutum is pale and two round red spots occur on the back behind the scutum (figs. 14 and 15).

Fig. 14. *Dermacentor rhinocerotis* (de Geer, 1778) ♂ : dorsum (Neumann, 1897).

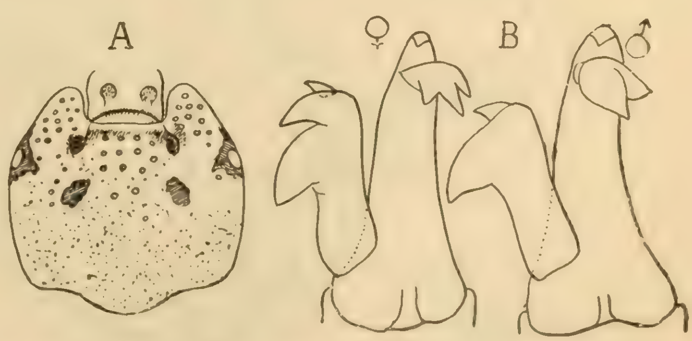


Fig. 15. *Dermacentor rhinocerotis* (de Geer, 1778) ♀ scutum ; ♀ and ♂ digits highly magnified (Neumann, 1897).

Genus 4. Rhipicentor.

Generic characters: Inornate, with eyes and festoons, with short palps, basis capituli hexagonal dorsally and having prominent lateral angles. Coxa I. bifid. The male resembles Dermacentor *ventrally and* Rhipicephalus *dorsally.*

Of the two species belonging to this genus one has been found in the Congo:—

(1) *Rhipicentor bicornis,* Nuttall and Warburton, 1908. The species is best described by the reference to our illustrations (figs. 16 and 17).

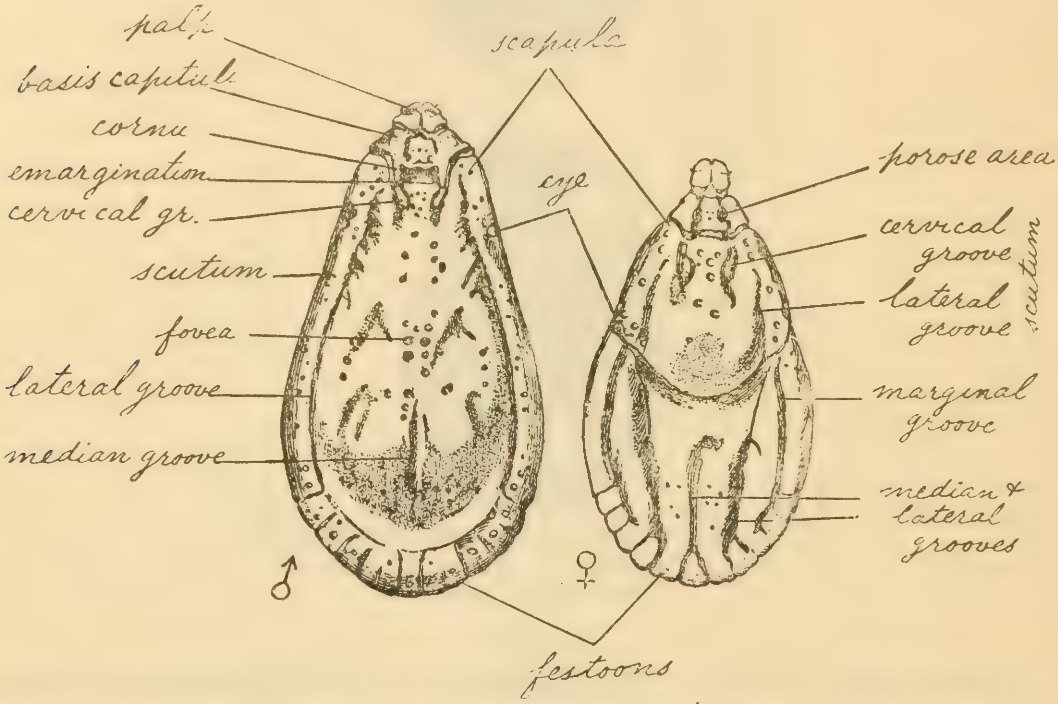


Fig. 16. *Rhipicentor bicornis*, Nuttall and Warburton, 1908, ♂ and ♀: dorsal aspects (N. & W. 1908).

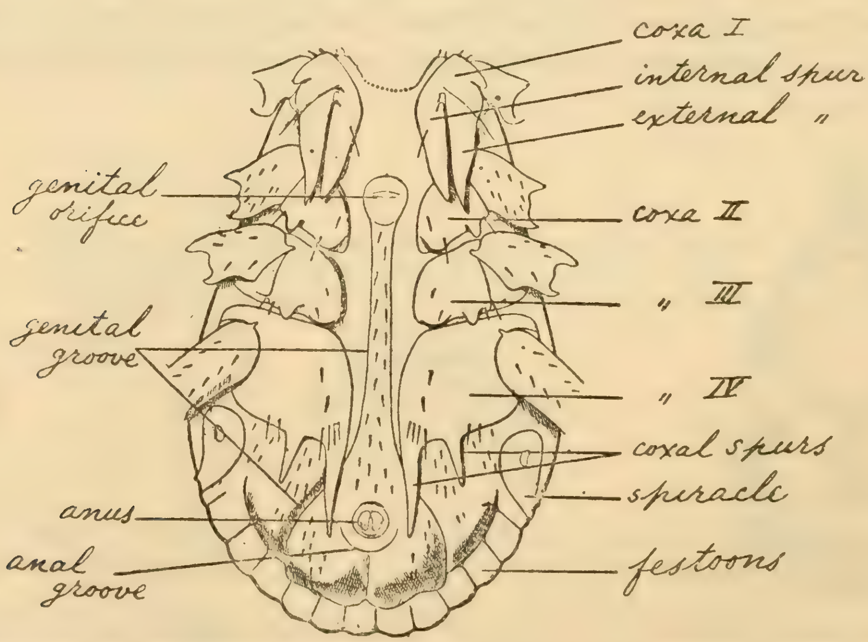


Fig. 17. *Rhipicentor bicornis* Nuttall and Warburton 1908, ♂: ventral aspect (Nuttall, 1908).

Genus 5. Rhipicephalus.

Generic characters: Usually inornate, with eyes and festoons, with short palps, and basis capituli usually hexagonal dorsally, coxa I. bifid. The male possesses a pair of adanal shields and usually a pair of accessory adanal shields; some males, when fully fed, show a caudal protrusion. Spiracles comma-shaped.

Nine species of *Rhipicephalus* are recorded from the Congo. It is a difficult matter to determine the species of this genus because of individual variations in size and structure as illustrated in figs. 18, 19, 25 and 26 relating to two species which occur in the Congo. When typical examples are examined the difficulty is considerably lessened, especially in the case of the males. The females are more difficult to determine and the beginner is advised to obtain expert opinion before reaching conclusions with regard to the species with which he is dealing. The following main characters will be helpful in roughly determining *typical male specimens* of the nine Congo species: –

(1) *R. appendiculatus*, Neumann, 1901. Characterized by adanal shields tending to be pointed posteriorly, scutum with many punctations. Coxa I. prominent when viewed dorsally. Note the shape of the basis capituli in the accompanying illustration. Fully fed males have a long caudal process (figs. 18–21). For biology see p. 344.

For figs. 18–21, see pages 324, 325, 326.

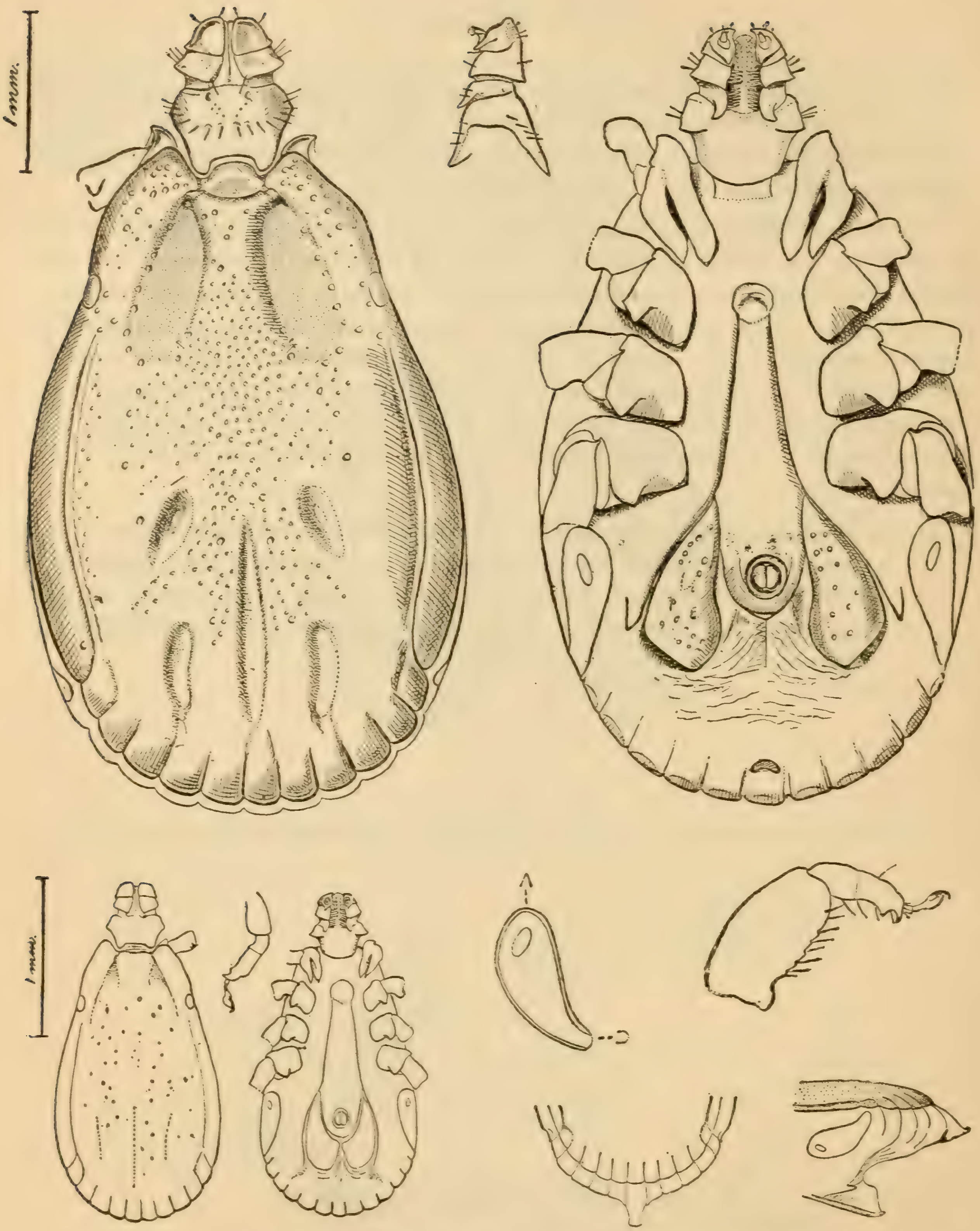


Fig. 18. *Rhipicephalus appendiculatus*, Neumann, 1901, ♂♂: (*a*) normally developed unfed specimen in dorsal and ventral aspects, capitulum in profile, spiracle and tarsus iv.; (*b*) small male, in dorsal and ventral aspects, which was removed from the host in the larval and nymphal stages before it had fed to repletion; the large and small males (brothers) are drawn to the same scale; a similar variation in size and structure is observed in nature; (*c*) dorsal and lateral aspects of a fully fed male (less magnified) showing caudal protrusion and the protruding adanal plates with abdomen distended beyond the contour of the scutum (Nuttall, 1913).

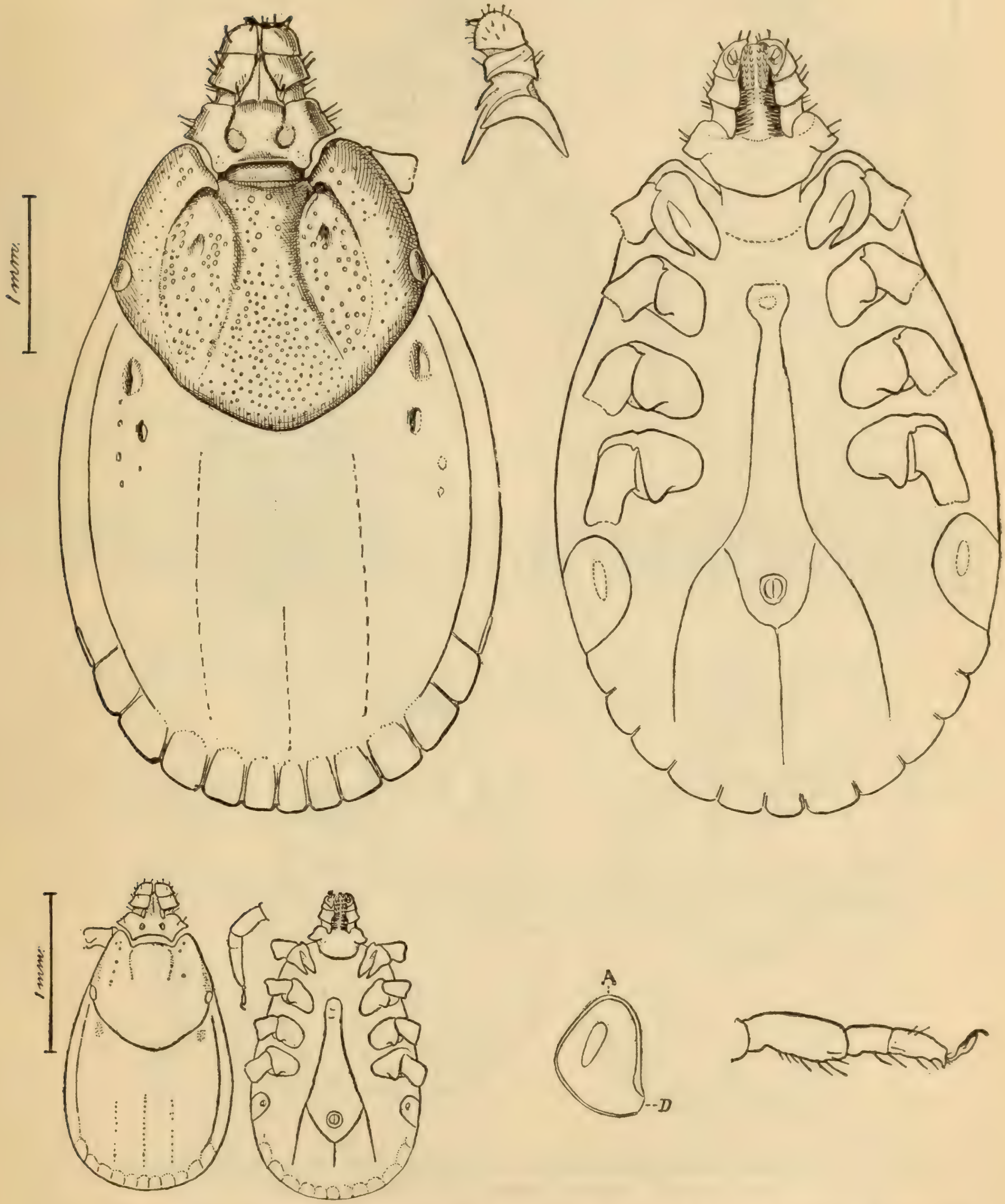


Fig. 19. *Rhipicephalus appendiculatus*, Neumann, 1901, ♀♀: (*a*) normally developed female in dorsal and ventral aspects, capitulum in profile, spiracle and tarsus iv.; (*b*) small female which was removed from the host before it had fed to repletion both as a larva and nymph. The large and small females (sisters) are drawn to the same scale. (Nuttall, 1913.)

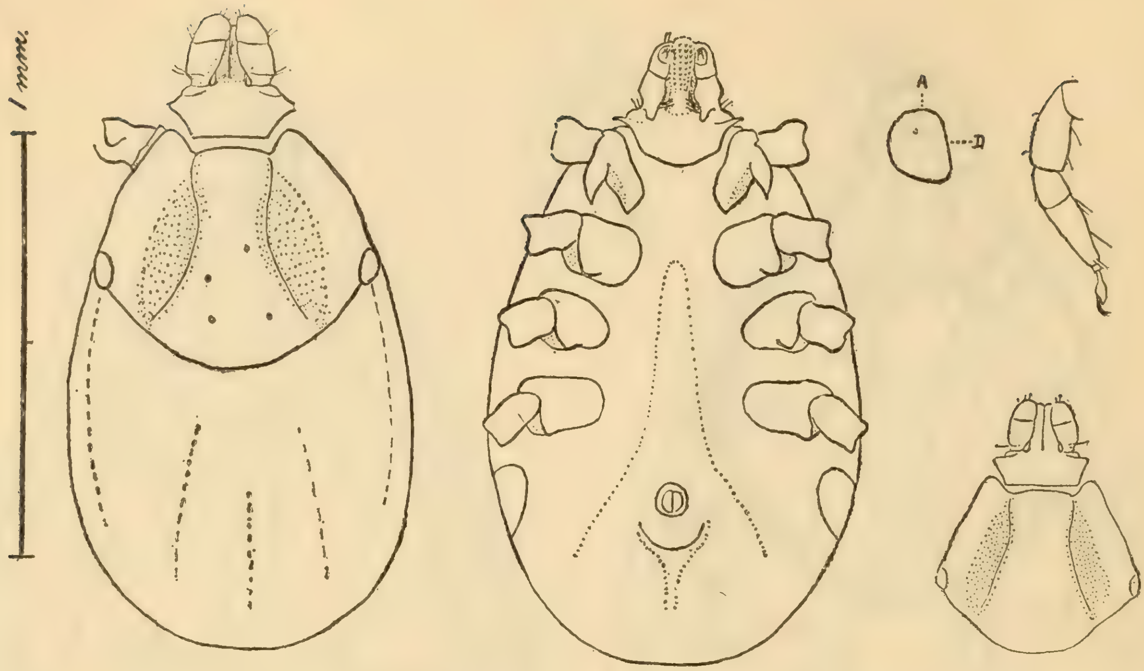


Fig. 20. *Rhipicephalus appendiculatus*, Neumann, 1901, nymphs: (*a*) normally developed unfed specimen, dorsal and ventral aspects, spiracle and tarsus iv.; (*b*) capitulum and scutum of nymph which emerged from a larva removed from the host before it had fed to repletion. Such small nymphs occur in nature. (Nuttall, 1913.)

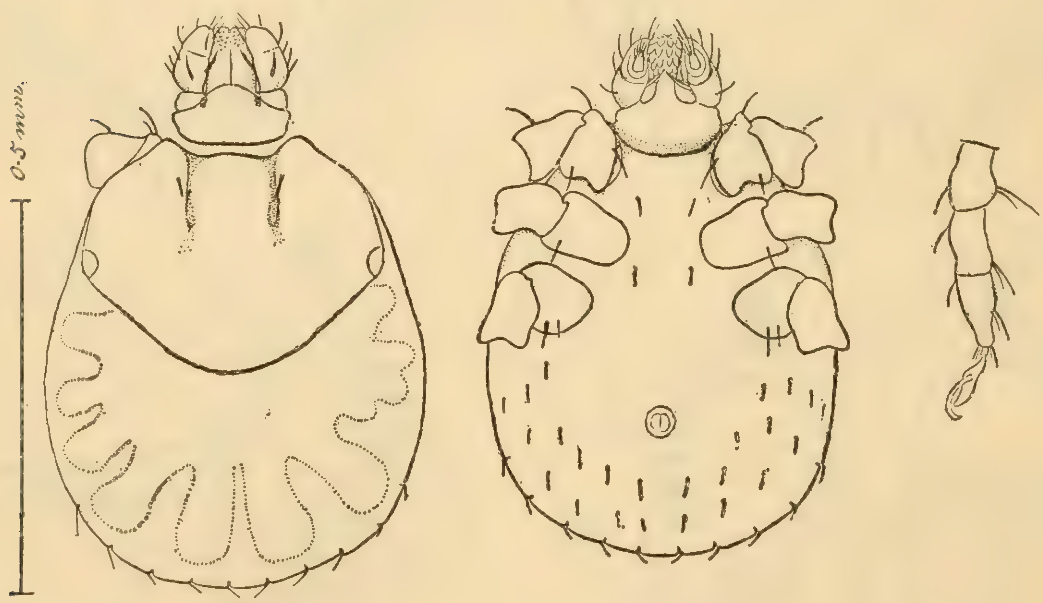


Fig. 21. *Rhipicephalus appendiculatus*, Neumann, 1901, unfed larva: dorsal and ventral aspects, tarsus iii. (Nuttall, 1913.)

(2) *R. capensis*, Koch, 1844. The scutum shows many punctations, and this, combined with rugosities covering its surface, give it a dull appearance. The adanal shields are rounded behind. The species is uncommon. The determination is difficult. For biology see p. 344.

(3) *R. evertsi*, Neumann, 1897. Characterized by its dark brown scutum, bead-like eyes and reddish yellow legs (fig. 22). It is commonly known as the red-legged tick in South Africa. For biology see p. 345.

R. evertsi var. *albigeniculatus*, Warburton, 1915 (n. var.), received by us from the Lower Congo, only differs from the above in having banded legs. On superficial examination it might easily be confounded with *Hyalomma aegyptium*.

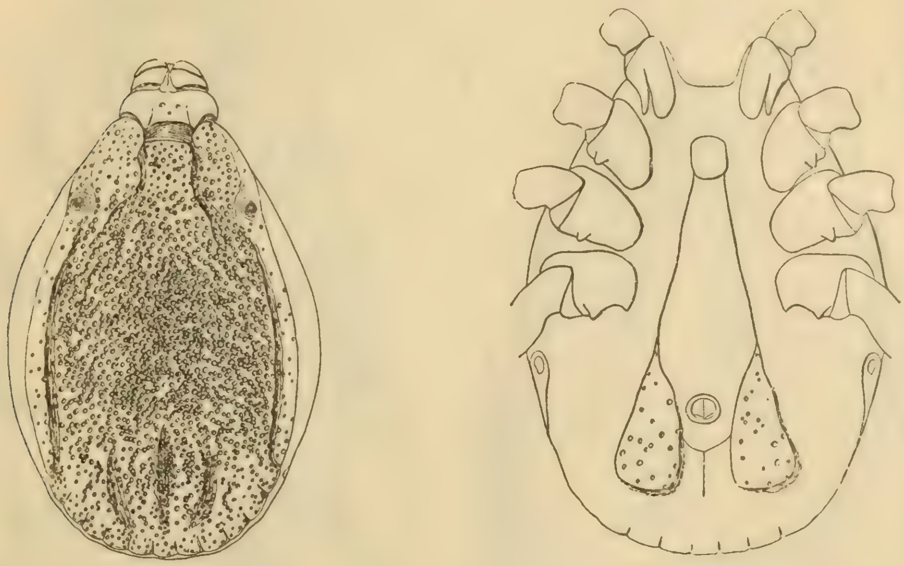


Fig. 22. *Rhipicephalus evertsi*, Neumann, 1897, ♂: dorsum and venter (original, L. E. Robinson).

(4) *R. falcatus*, Neumann, 1908. Scutum very coarsely punctate; sickle-like adanal shields (fig. 23).

(5) *R. lunulatus*, Neumann, 1907. Adanal shields with two points (bifid) at the posterior margin (fig. 24). Otherwise the species resembles *R. simus* (no. 7).

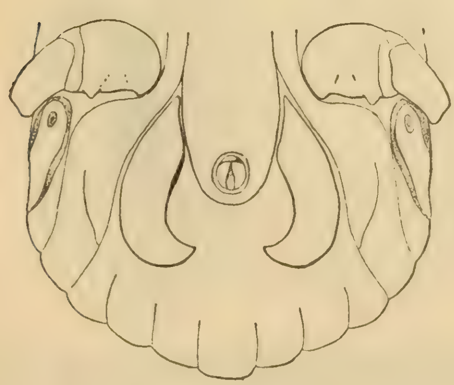


Fig. 23. *Rhipicephalus falcatus*, Neumann, 1908, ♂: posterior part of venter (Neumann, 1908).

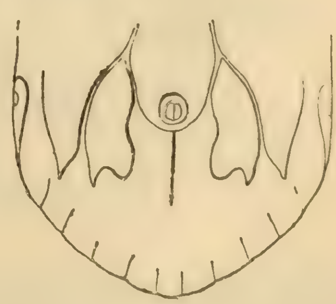


Fig. 24. *Rhipicephalus lunulatus*, Neumann, 1907, ♂: posterior part of venter (Neumann, 1907).

(6) *R. sanguineus* (Latreille, 1804). A common species. Colour reddish brown. Scutum with punctations of variable size, with three characteristic posterior furrows. Adanal shields rounded behind. When fully fed the male may show a slight caudal protrusion (figs. 25–28). For biology see p. 345.

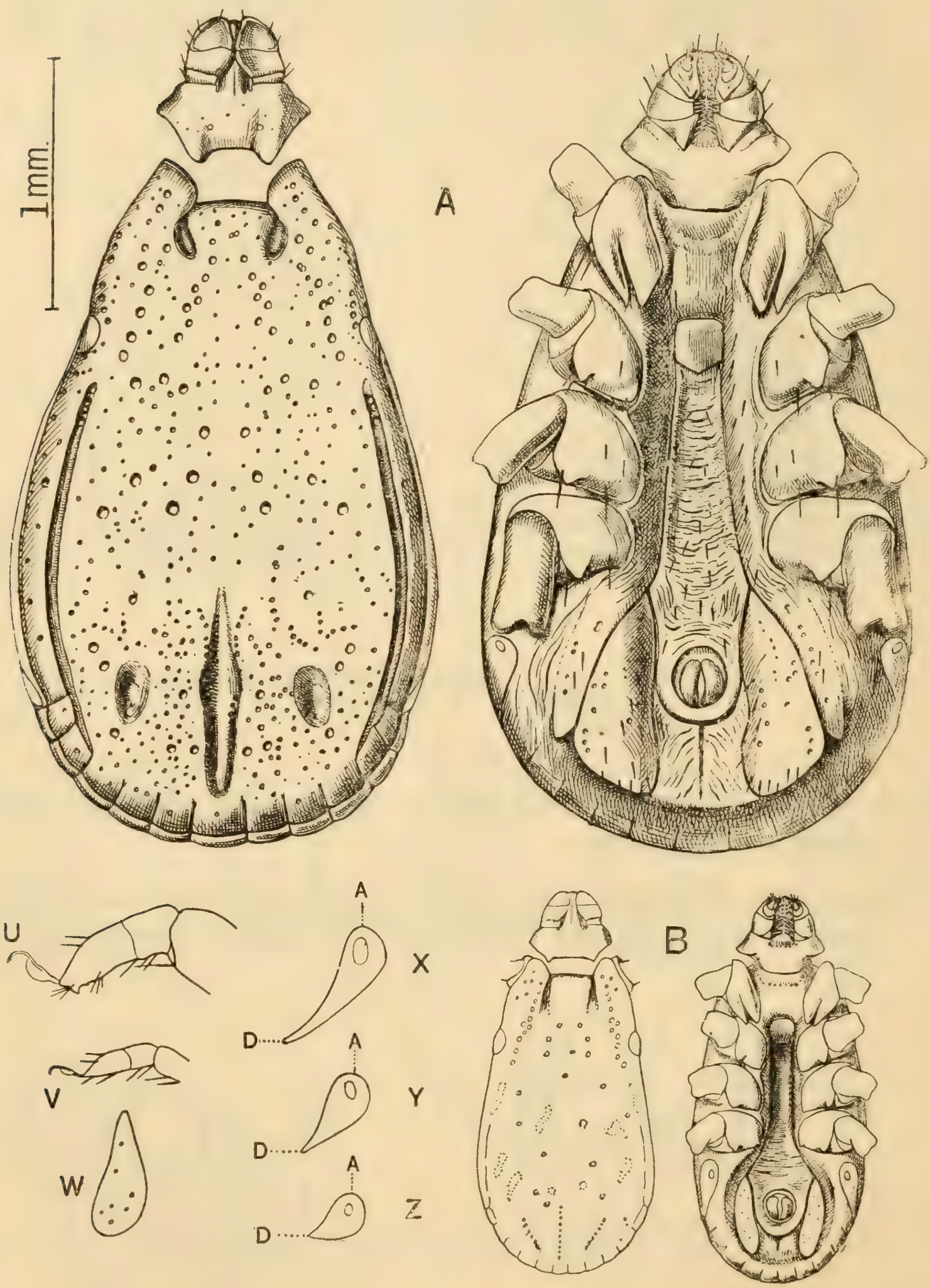


Fig. 25. *Rhipicephalus sanguineus* (Latreille, 1804) ♂♂ : (A) normally developed specimen in dorsal and ventral aspects, (X) and (U) its spiracle and tarsus ; (B) dwarf male which was picked off the host before it became fully gorged, in both larval and nymphal stages, (Z) and (V) its spiracle and tarsus ; (W) and (Y), intermediate forms of adanal plate and spiracle respectively. (N. Cunliffe, 1914.) A similar variation in size and appearance is observed in nature.

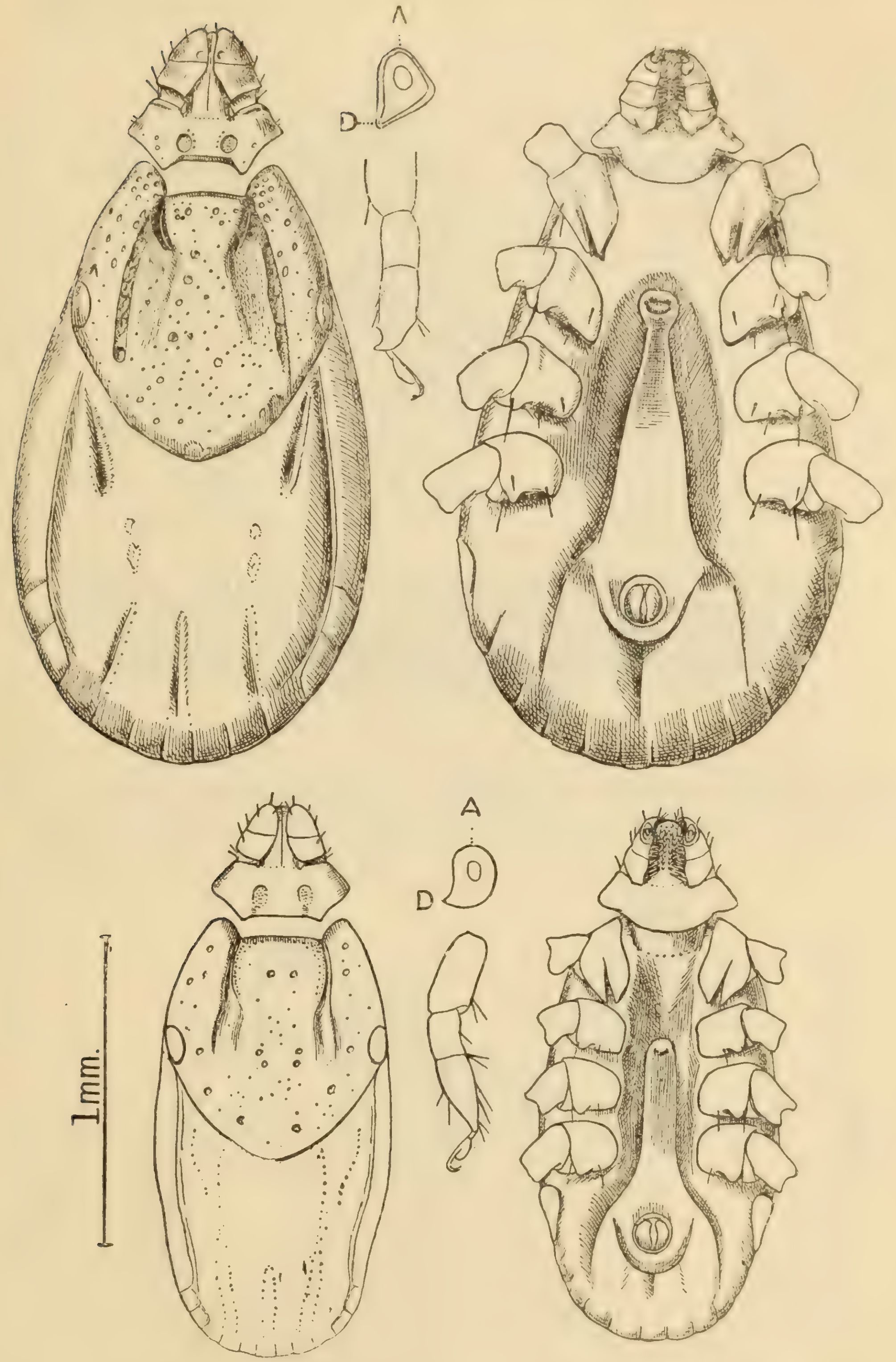


Fig. 26. *Rhipicephalus sanguineus* (Latreille, 1804), ♀♀: (1) normally developed specimen in dorsal and ventral aspects, spiracle and tarsus iv.; (2) small female, which was picked off the host in both larval and nymphal stages, before it became fully gorged. (N. Cunliffe, 1914.)

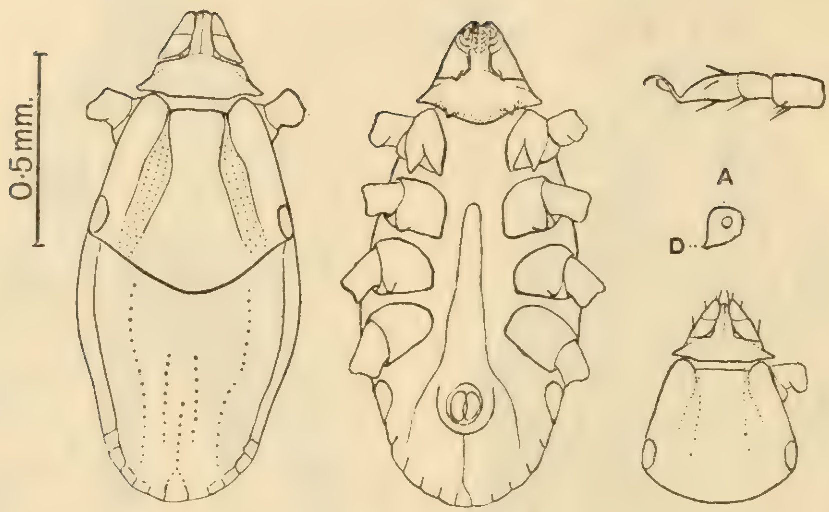


Fig. 27. *Rhipicephalus sanguineus* (Latreille, 1804), nymphs: (1) normally developed unfed specimen, dorsal and ventral aspects, spiracle and tarsus iv.; (2) capitulum and scutum of nymph which emerged from a partially gorged larva. (N. Cunliffe, 1914.)

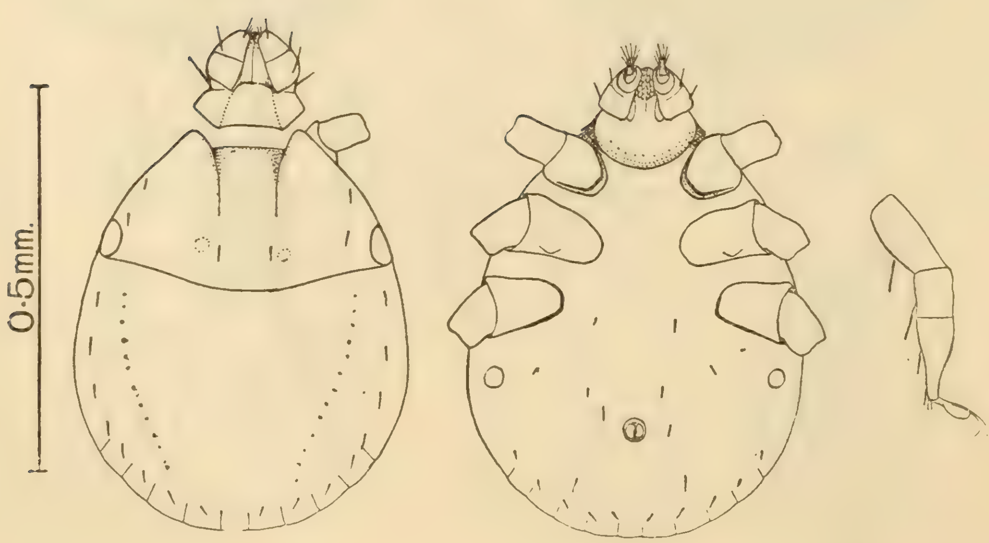


Fig. 28. *Rhipicephalus sanguineus* (Latreille, 1804), unfed larva: dorsal and ventral aspects, tarsus iii. (N. Cunliffe, 1914.)

(7) *R. simus*, Koch, 1844. Scutum dark, glossy, with *few* punctations somewhat linearly arranged. Adanal shields usually rounded behind (fig. 29). For biology see p. 345.

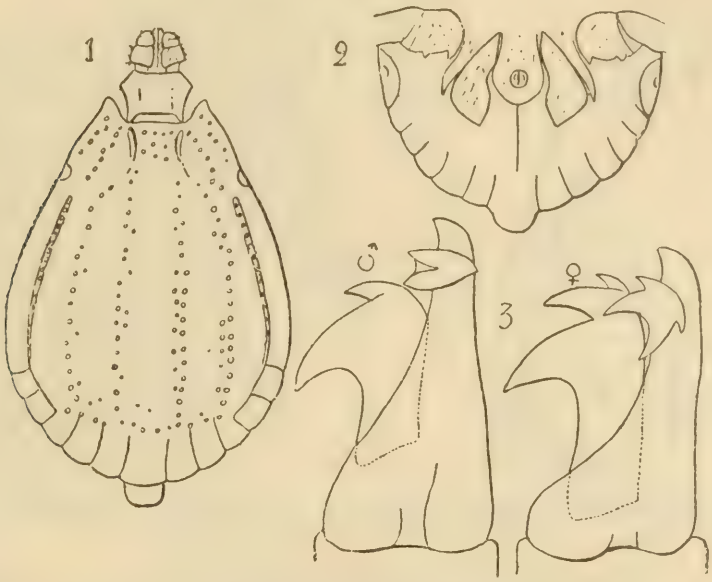


Fig. 29. *Rhipicephalus simus*, Koch, 1844, ♂: (1) dorsum; (2) posterior part of venter; (3) digits of ♂ and ♀ × 195. (Neumann, 1897.)

(8) *R. supertritus*, Neumann, 1907. Scutum very rugose. Adanal shields rounded behind. When replete the soft integument protrudes posteriorly in the form of three lobes (fig. 30).

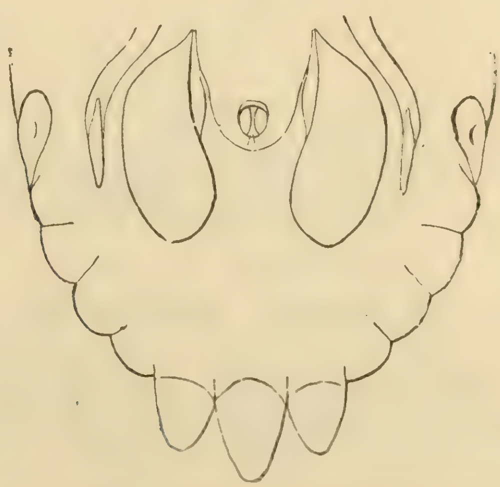
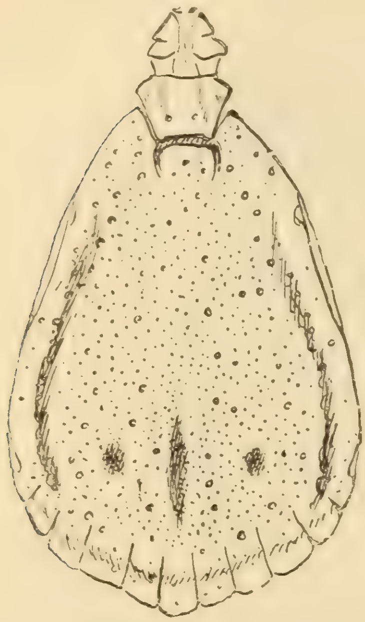


Fig. 30. *Rhipicephalus supertritus*, Neumann, 1907, ♂: posterior part of venter of distended specimen. (Neumann, 1907.)

(9) *R. tricuspis*, Dönitz, 1906. Resembles *R. sanguineus*, but the adanal shields are bifid as in *R. lunulatus* (figs. 31 and 32).



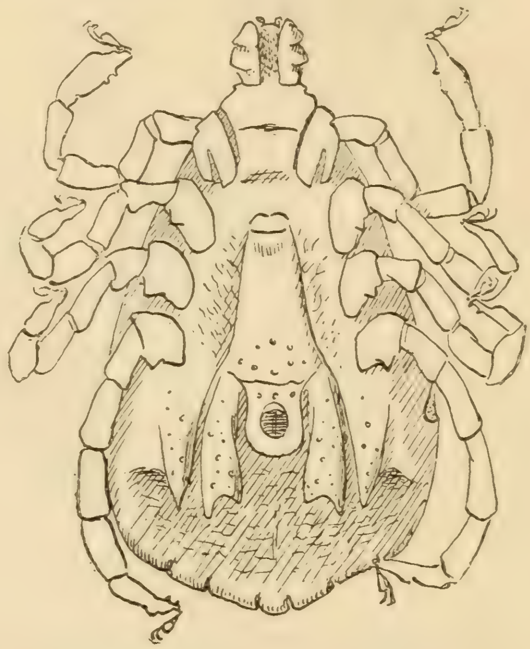


Fig. 31. ***Rhipicephalus tricuspis***, Dönitz, 1906, ♂: dorsum and venter (Dönitz, 1906).

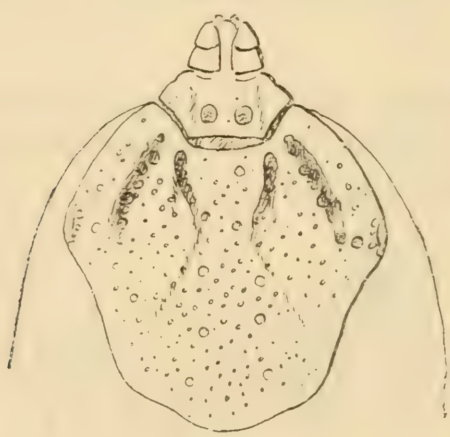


Fig. 32. ***Rhipicephalus tricuspis***, Dönitz, 1906, ♀: capitulum and scutum (Dönitz, 1906).

Genus 6. Margaropus.

Generic characters : Anal grooves obsolete ; inornate, with eyes, but without festoons, with short palps, and capitulum intermediate between that of Rhipicephalus *and* Boophilus, *highly chitinized and of large size. The female with very small scutum. The male with a median abdominal plate prolonged in two long spines projecting beyond and to either side of the anus ; the articles of the legs, especially of leg IV. greatly swollen ; tarsi in both sexes with a long sharp spur extending far beyond the claws, which are small and functionless ; a caudal protrusion present in the male. Spiracles rounded or short oval in both sexes.* (Figs. 33 and 34.)

The genus comprises but one species, *Margaropus winthemi*, Karsch, 1879, occurring in South Africa ; rare.

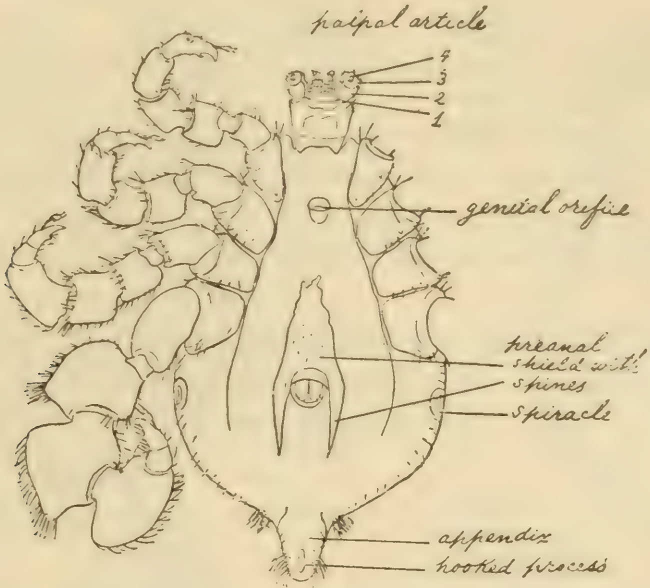


Fig. 33. *Margaropus winthemi*, Karsch, 1879, ♂ : ventral aspect (Neumann, 1907).

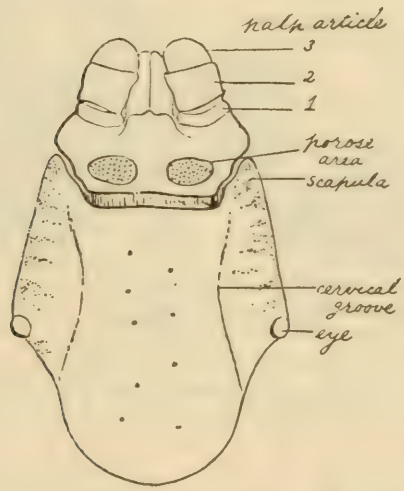


Fig. 34. *Margaropus winthemi*, Karsch, 1879, ♀ : capitulum and scutum (Nuttall and Warburton, 1911).

Genus 7. Boophilus.

Generic characters : Anal grooves obsolete ; inornate, with eyes, but without festoons ; with very short compressed palps ridged dorsally and laterally ; basis capituli hexagonal dorsally ; slightly chitinized ; the unfed adults of small size. Coxa I. bifid. The female with a small scutum ; the male with adanal and accessory adanal shields. Spiracles rounded or oval in both sexes.

The genus is represented in the Congo by one species : *Boophilus decoloratus* (Koch, 1844) whose characters are shown in the accompanying illustrations. (A closely allied species or variety *B. australis*, Fuller, may also be found to occur in the Congo.) (Figs. 35 and 36.) For biology see p. 345.

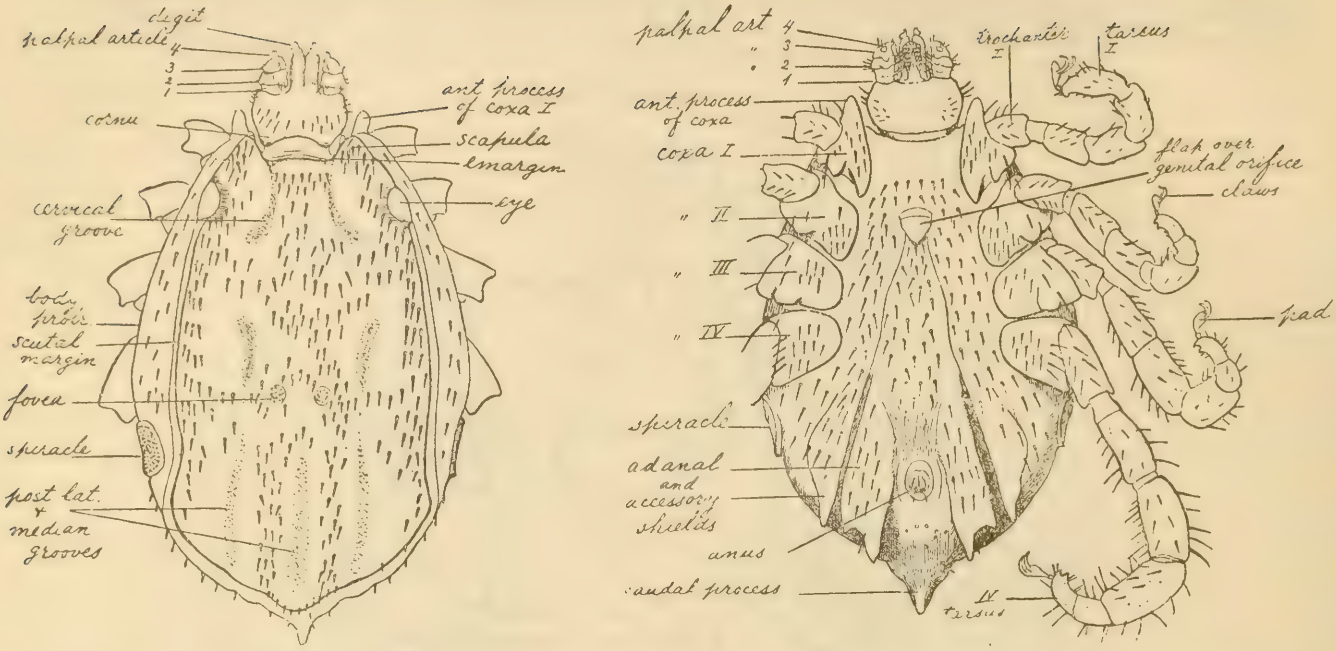


Fig. 35. *Boophilus decoloratus* (Koch, 1844), ♂: dorsum and venter (Nuttall, 1909).

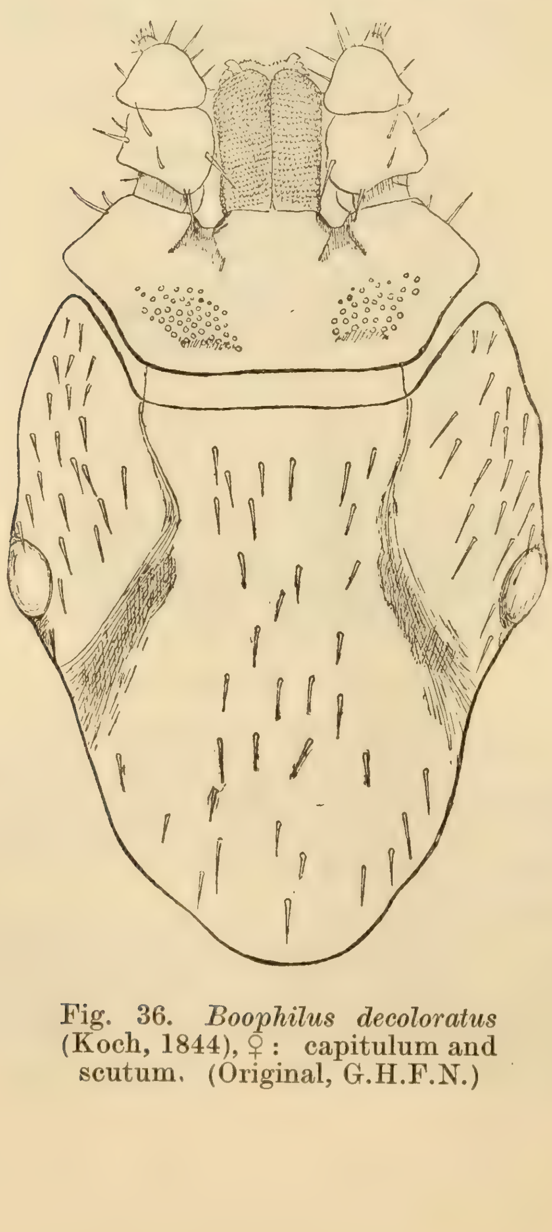


Fig. 36. *Boophilus decoloratus* (Koch, 1844), ♀: capitulum and scutum. (Original, G.H.F.N.)

(*b*) *LONGIROSTRATA.*

Group I.

Genus 8. Hyalomma.

Generic characters : Scutum inornate (or rarely ornate); legs at times banded with light markings; with eyes, with or without festoons, with long palps, basis capituli subtriangular dorsally. The female approaching Amblyomma *in appearance. The male with adanal shields and paired chitinized points borne on posterior abdominal protrusions. Coxa I bifid. Spiracles comma-shaped.*

The genus is represented in the Congo by one species: *Hyalomma aegyptium* (Linnaeus) which can be readily recognized by the characters depicted in the illustrations (figs. 37 and 38). For biology see p. 346.

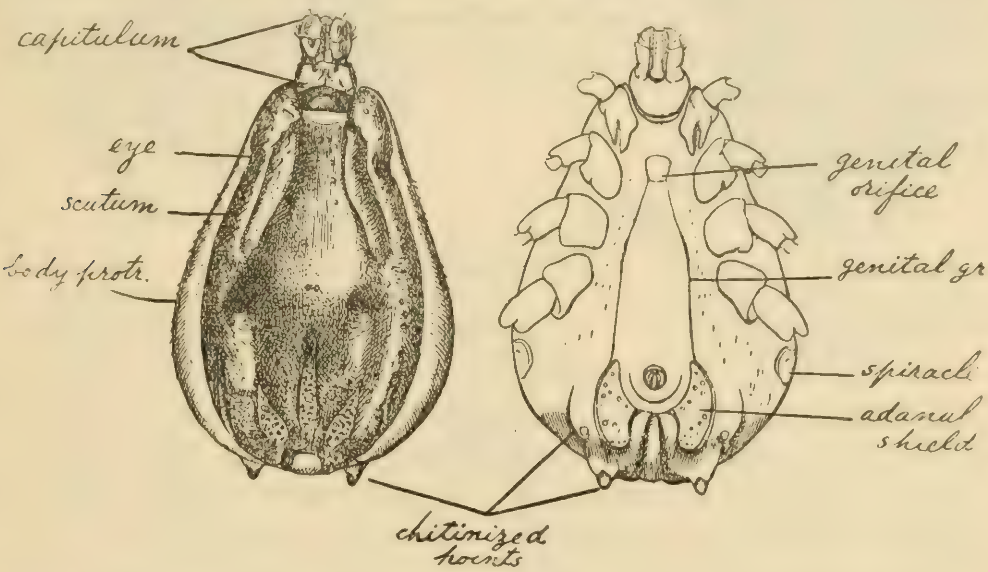


Fig. 37. *Hyalomma aegyptium* (Linn.), ♂: dorsum and venter (Nuttall and Warburton, 1909).

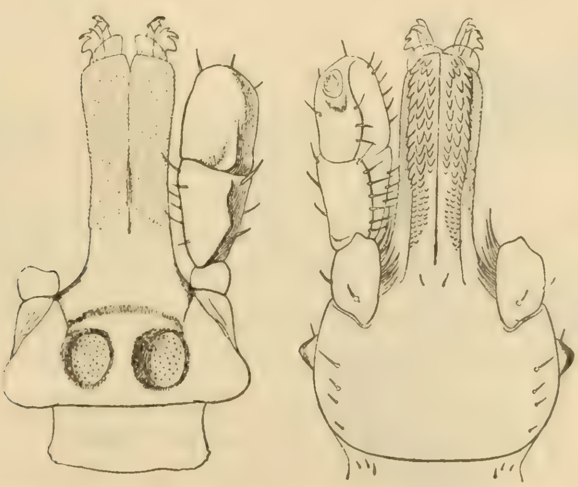


Fig. 38. *Hyalomma aegyptium.* (Linn.), ♀: capitulum in dorsal and ventral aspects (Nuttall, 1911).

Group II.

Genus 9. Amblyomma.

Generic characters : generally ornate, with eyes and with festoons. With long palps ; basis capituli of variable form. The male without adanal shields, but small ventral plaques are occasionally present close to the festoons. Spiracles subtriangular or comma-shaped.

There are eight species of *Amblyomma* recorded from the Congo. The males are more readily identified than the females, and for practical purposes in the field they can be determined by naked eye inspection alone or by means of a hand lens—the species referred to are all large and ornate. A simple means of identification is afforded by the colour and nature of the ornamentation and these will serve our present purposes. We describe the colours of the scutum as seen by us in living *male* specimens unless the contrary is noted. The colours in *Amblyomma* and *Aponomma* usually take on a metallic lustre when the ticks are preserved in alcohol ; they are frequently lost in badly preserved specimens.

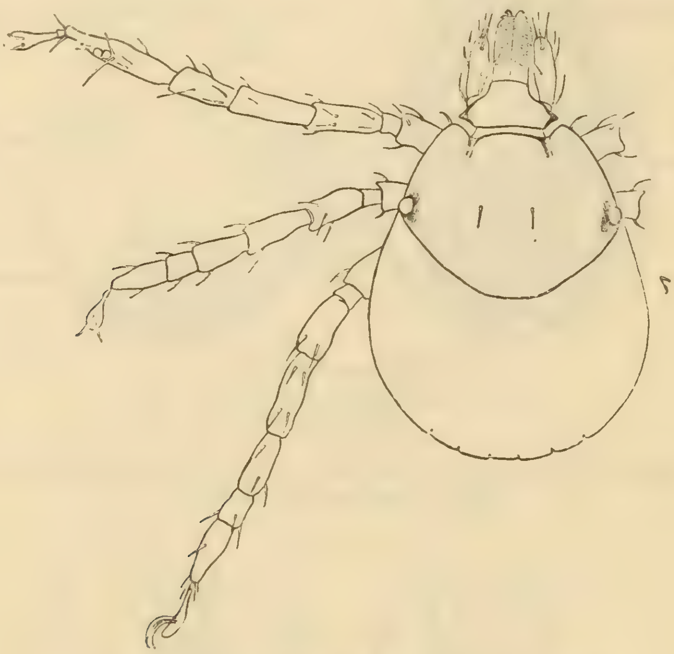


Fig. 39. *Hyalomma aegyiium* (Linn.), larva (Original, G.H.F.N. del.).

(1) *A. variegatum* (Fabricius, 1794). All the festoons and dark areas are black, the light areas are reddish yellow bordered with green. When the ticks die and dry, the dark areas turn brown, the lighter areas turn yellow to orange. The eyes are bead-like in both sexes (fig. 40). A common species.

(2) *A. splendidum*, Giebel, 1877. Easily recognized by a circular bright orange spot in the middle of its back ; the median festoon and dark parts are black and the four festoons flanking the median one are white. The median light areas of the scutum are violet, the lateral pinkish, but they turn yellow in the dead dry tick, whilst the orange spot persists (fig. 41 and 42). Appears to be common.

(3) *A. cohaerens*, Dönitz, 1909. We have not as yet seen this tick in a living condition. In dried and in alcohol specimens it closely resembles *A. splendidum* in colour and scutal markings. The only observable difference consists in the absence of the orange spot. The species also appears to be common. It would be of interest to determine the geographical distribution of *splendidum* and *cohaerens*, as the slight difference points to their being merely varieties of one species.

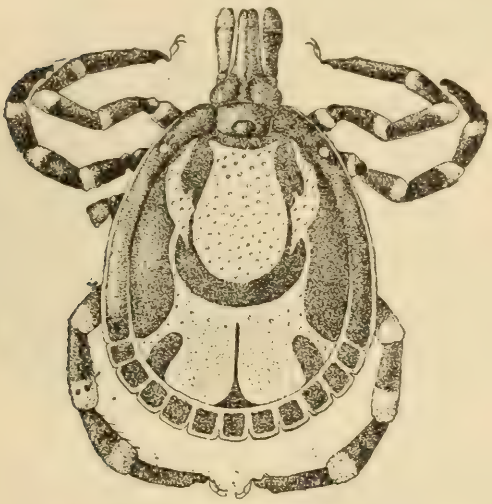


Fig. 40. *Amblyomma variegatum* (Fabricius, 1794), ♂: dorsum (from drawing by J. Marx, published by Neumann, 1899).

Fig. 41. *Amblyomma splendidum* Giebel 1877, ♂: dorsum (Original, G.H.F.N.).

(4) *A. hebraeum*, Koch, 1844. The festoons are whitish, the two spots at the sides yellowish, the greater part of the light areas are pale violet or pinkish and the dark parts are black (fig. 43). When the tick dies and is allowed to dry, the light areas turn pale yellow. Males that have been a long time upon the host (70 days or more) turn reddish in the light areas about the eyes and sides and the light portions of the back turn greenish. The light areas in the female are yellowish and turn paler when they die. For biology see p. 347.

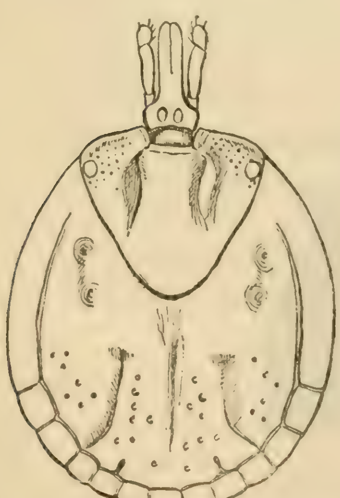


Fig. 42. *Amblyomma splendidum* Giebel 1877, ♀: dorsum (Original, G.H.F.N.).

Fig. 43. *Amblyomma hebraeum* Koch 1844, ♂: scutum (Robinson, 1915).

(5) *A. pomposum*, Dönitz, 1909. The festoons are dark, the three light areas anteriorly are yellow, a large median and two lateral patches are red, the postero-lateral and posterior markings are greenish. These appearances are described from dead specimens preserved in alcohol or dried. The accompanying illustration accurately renders the disposition of the colour pattern (fig. 44).

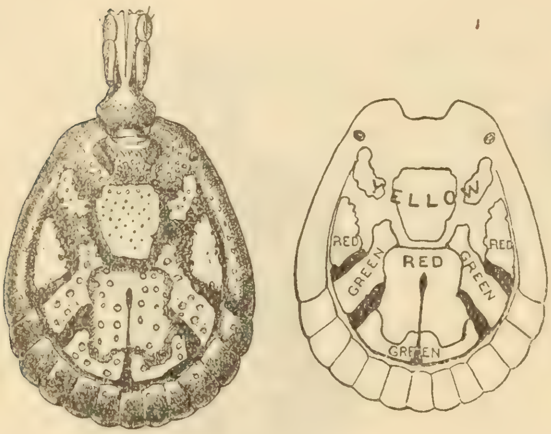


Fig. 44. *Amblyomma pomposum*, Dönitz 1909, ♂: dorsum and index to coloured pattern (Original, G.H.F.N.).

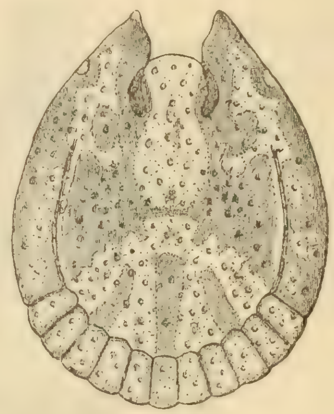


Fig. 45. *Amblyomma marmoreum*, Koch 1844, ♂: scutum (Neumann, 1901).

(6) *A. tholloni*, Neumann, 1899. In alcohol specimens the dark portions are brown, whilst eight small yellow patches occur along the sides extending backward from the scapulae and being almost equidistant from each other.

(7) *A. marmoreum*, Koch, 1844. Numerous irregular light yellowish areas occur over the scutum and festoons, they may be more or less obliterated in old ticks or in badly preserved specimens (fig. 45.)

(8) *A. trimaculatum*, Neumann, 1908. We have not seen the male of this species. The female scutum shows three light spots (fig. 46).

Fig. 46. *Amblyomma trimaculatum*, Neumann 1908, ♀: capitulum and scutum (Neumann, 1908).

Sub-genus Aponomma.

Aponommas may be regarded as merely Amblyommas without eyes or in which the eyes are poorly developed. The body is frequently broad. They occur, in Africa, only on Reptilia.

Two species are recorded from the Congo :—

(1) *Aponomma exornatum*, Koch, 1844. The male shows nine light spots on the scutum, of which two are situated on the scapulae, two antero-laterally, one large one centrally and four posteriorly to the foregoing. There are three spots on the female scutum (fig. 47).

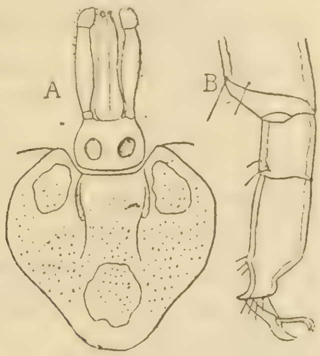


Fig. 47. *Aponomma exornatum* (Koch 1844), ♀: (A) capitulum and scutum; (B) tarsus iv. (Neumann, 1899.)

(2) *Aponomma laeve*, Neumann, 1899. Colour light brown, inornate.

General Biology of Ticks.

1. *Feeding habits.*

All ticks are parasitic and their sole food consists of blood which they suck from their hosts, but at times they may imbibe a certain amount of lymph, if they fail to reach a blood-vessel with their mouth-parts.

A considerable difference exists between Argasidae and Ixodidae with regard to their feeding habits. The larvae of both groups feed in the same manner as a rule, usually remaining upon the host for less than a week.

The nymphs and adults of Argasidae, with but one exception (*Ornithodorus megnini* in America), are rapid and frequent feeders, filling themselves with blood usually in fifteen to thirty minutes; they, like bed-bugs, attack their hosts chiefly at night and infest his habitats or resting places. The females lay but a moderate number of eggs, usually less than 200, in batches after each meal of blood. The Argasidae can fast at times for 3–4 years. Both sexes are blood-suckers (*O. megnini* ♂ excepted.)

The nymphs and adults of Ixodidae remain for a week or more upon the host. The females lay several thousands of eggs, feed but once, and die after oviposition is completed. Partially fed Ixodidae when removed from the host, unless they undergo metamorphosis, usually die in a few days. On the other hand, when unfed, they may remain alive for weeks, months or a year or two, provided the conditions are favourable.

In only one species (*Haemaphysalis inermis* of Europe) are the larvae and nymphs known to be rapid feeders. As a rule both sexes are found together upon the host, where they may occasionally be found in copulation, but in some IXODIDAE (*Ixodes* especially) the males do not feed. In the latter case the males, after emerging from the nymphal skin, lie in wait for the females which drop off gorged from the host in its burrow or nest. This difference in the behaviour of the sexes depends, as Nuttall has shown, upon the habits of the host. Wandering animals usually have species of ticks upon them which cohabit upon the host, whereas hosts with fixed habitats (burrows or nests) more usually have only females upon them. Whereas the males of ARGASIDAE partake of a full meal of blood, as do the females, the males of IXODIDAE feed very sparingly and chiefly it would appear on lymph, for we have failed to find red blood corpuscles in their alimentary canals, although we have examined many specimens.

As a rule, larvae and nymphal ticks abandon their host after feeding, and, falling to the ground, undergo metamorphosis to the next stage upon the ground. Such ticks are known as three-host ticks, for they require to have access to a host on three occasions, when they feed in the larval, nymphal and adult stages. Of the Congo ticks, *Amblyomma hebraeum*, *A. variegatum* and *Haemaphysalis leachi* may be taken as examples of three-host ticks. Other ticks undergo one moult upon the host and re-attach themselves to the same host when they emerge. An example of such a two-host tick is *Rhipicephalus evertsi*, wherein metamorphosis from larva to nymph takes place upon the host. In *Boophilus*, on the other hand, we have a one-host tick, for it remains upon a single host throughout its development from larva to replete adult.

As previously stated, the males of IXODIDAE, when they feed, do so sparingly. All the other stages imbibe a large amount of blood in relation to their size. In the males the dorsal surface of the body is entirely covered with a hard scutum, whereas in the other stages the scutum is small and only covers the anterior portion of the body, the greater part of which is soft and consequently capable of great distension owing to its elastic integument. Many ticks are incapable of further development if they do not gorge to repletion; in others, partially engorged larvae and nymphs give rise to small nymphs and adults respectively. This accounts for the great variation in size observable in certain species, of which *Rhipicephalus appendiculatus* and *R. sanguineus* may serve as examples (figs. 18, 19, 25 and 26). Imperfectly gorged females frequently lay sterile eggs, and the number of eggs they lay is less than normal according to the degree of engorgement.

The mechanism of the bite is similar in all ticks. The paired cutting organs, or digits of the *chelicerae*, penetrate into the skin by means of their very sharp recurved teeth. Each chelicera (fig. 48) consists of a tubular shaft protruding from the base of the capitulum, and provided at its distal extremity with a cutting organ or digit. The latter is moved laterally by means of two tendons, an internal tendon which extends it and a more powerful external tendon which causes it to turn outward. Reference to the figure will render it clear how the chelicerae penetrate the tissues of the host when the tendons act alternately upon the terminal cutting organ with its sharp recurved teeth. Situated ventrally to the chelicerae is the rigid *hypostome*, bearing sharp recurved teeth. The hypostome is dragged into the wound inflicted by the chelicerae and its teeth serve to anchor the tick to the host without further

efforts on the part of the parasite. When the chelicerae and hypostome have penetrated sufficiently and the digits have cut the smaller blood vessels, the tick proceeds to suck in blood by means of a powerful pumping organ, the pharynx, which is situated in the capitulum. The blood, traversing the pharynx and oesophagus, enters the highly distensible intestinal caeca and the tick proceeds to swell in size. The blood is imbibed slowly at first, the maximum increase in the engorgement of the tick usually taking place during the last twenty-four hours (in Ixodidae) before the parasite abandons the host.

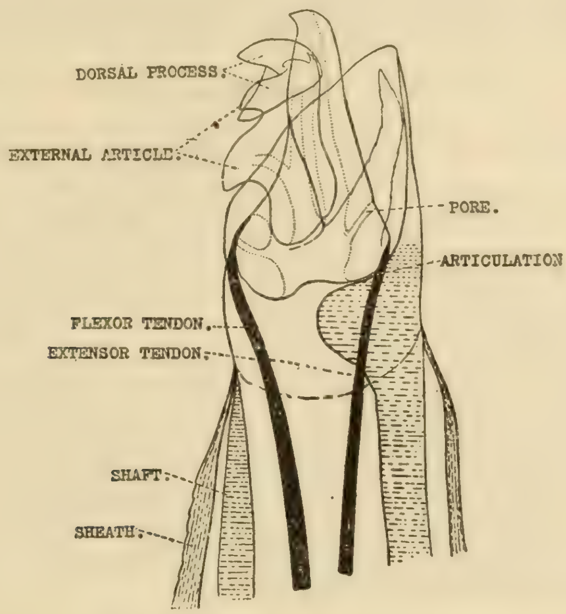


Fig. 48. *Haemaphysalis cinnabarina* var. *punctata*, (Canestrini and Fanzago, 1877), ♀: showing mechanism of chelicera (Nuttall, Cooper and Robinson, 1908).

Owing to the structure of the tick's mouth-parts they are frequently injured when the parasite is forcibly removed from its seat of attachment. Due care should therefore be taken in removing a tick, a fine pair of forceps with which the mouth-parts are grasped, will be found useful for the purpose. If the broken off mouth-parts are left in the wound considerable irritation may be produced, over and above that which is occasionally caused by the bite itself.

The *salivary secretion* of ticks has been shown by Nuttall to contain an anti-coagulin, and there is reason to suppose that it may at times exert a toxic action.

Whilst feeding, this being especially observable in ARGASIDAE (*Ornithodorus moubata* and to a lesser degree in *Argas persicus*), ticks may give off considerable quantities of clear fluid from glands whose ducts emerge between the coxae of the first and second pairs of legs. This secretion of the coxal glands likewise contains an anti-coagulin. Ticks frequently void excreta whilst feeding.

The function of the anticoagulin is obviously that of preventing the coagulation of the blood and consequently promoting its flow. (See further under *O. moubata*, biology p. 345.)

There can be no question but that massive tick infestation may be fatal. Animals have been known to die from " tick worry."

2. *Oviposition.*

The replete and fecundated female seeks shelter on the ground and after a variable period of time, depending on temperature, proceeds to lay eggs. If disturbed or roughly handled whilst ovipositing the female may cease to lay or she may die. A female may lay a few hundred up to thousands of eggs, depending upon the species. *Amblyomma hebraeum* may lay up to 18,500 eggs, *Rhipicephalus sanguineus* 4,000, *R. appendiculatus* 5,800, *Haemaphysalis leachi* 4,800, *Hyalomma aegyptium* 15,500. The process of oviposition is remarkably interesting to observe ; illustrated descriptions of the process will be found in our work, *Ticks* (Parts II and III).

3. *Development.*

The eggs, when first laid, are brownish and transparent. To undergo development they require a suitable degree of temperature and moisture. After some days the eggs appear clouded and a white spot (due to the Malpighian glands developing and accumulating excrement) appears on one side of the egg. Some days later the shell splits and the small six-legged larva emerges. The larvae soon darken, their chitinous exoskeleton hardens, and they scatter in search of a host. The larva of Ixodid ticks frequently accumulate in clusters of several hundreds or thousands upon the ends of blades of grass or herbage, and, coming to rest, wait for a passing host. If fortune favours them, they promptly cling to the host by means of their sharply clawed feet, which are likewise provided with pulvilli. Seeking a suitable spot on the skin of the host they insert their mouth-parts and proceed to feed. They usually become engorged in three to five days and then drop from the host.

The replete larva remains torpid until it casts its skin and the tick emerges as an eight-legged nymph, which again mounts the herbage and waits for its host. If a host is found, the nymph behaves as did the larva. The nymphs give rise to adults. These in turn wait for a host and attack it in the same manner as do the other stages.

The length of time the tick remains upon the host varies somewhat according to the species. Examples of different periods of parasitism will be found under the special biological notes which follow. If the ticks do not tap a good blood supply they may remain for a longer time upon the host. Moreover, if the host is a cold-blooded animal, the period of parasitism may be greatly prolonged. The males frequently remain upon a host for weeks after the females have dropped off, this explains why males may at times be present in larger numbers upon an animal.

Metamorphosis is markedly influenced by temperature, being accelerated by warmth and greatly retarded or completely checked by cold.

The relation of certain ticks to disease is referred to briefly under the species whose biology is described in the text which follows.

Special Biology of Congo Ticks and their Relation to Disease.*

Ornithodorus moubata occurs in native huts and resting places, hiding in the dust or thatch. It feeds chiefly at night and imbibes blood rapidly like the bed-bug. The fertilized female feeds repeatedly and lays a variable number of eggs after each

* The observations here recorded were carried out by me in Cambridge.—G. H. F. N.

meal of blood, the total number of eggs laid by each female being 100–150. The eggs, like those of other ticks, are agglutinated in masses and are much larger than in Ixodidae. By the 6th day, at 29° C., the larva has developed within the egg, but is a helpless creature incapable of feeding. Whilst still in the egg-shell the nymph develops within the larval skin, and usually about 10–15 days after the eggs were laid the nymphs emerge, throwing off the egg-shell plus the larval skin. The nymph is known as a first stage nymph, for there may be three or four nymphal stages passed before the tick attains sexual maturity. The first stage nymph is ready to feed very soon after emergence, and, having gorged, it undergoes metamorphosis and moults to feed again as a second stage nymph, etc. The nymphs and adults take 10–120 minutes to feed. The adults pair away from the host. This tick lives for many months when unfed; in the laboratory it has survived for two years. Depending on temperature, it may take a year or two to complete its life-cycle.

Relation to Disease : *O. moubata* conveys relapsing fever to man in many parts of tropical Africa, where the tick is widely distributed. When the tick imbibes blood containing *Spirochaeta duttoni*, it is capable of infecting persons upon whom it subsequently feeds. The progeny of an infected female remains infective up to the third generation and perhaps longer. The spirochaetes are therefore parasites both of man and of the tick. When feeding, the tick frequently exudes white excreta and a watery fluid, the latter issuing from large pores between the first and second legs on each side. This fluid prevents the coagulation of the blood. The excreta are infective, and the spirochaetes may enter the wound either from the excreta mixed with the anti-coagulating fluid about the bite, or more directly through the mouth-parts of the tick.

Prevention : When possible, infested quarters should be destroyed by fire. Native huts where ticks occur should be shunned. Sleeping in hammocks and under mosquito nets affords protection. The ticks may be encountered in resting places and old camps, and may be transported in a traveller's luggage.

Haemaphysalis leachi requires three hosts upon which to feed in the larval, nymphal and adult stages. The female may lay up to about 5,000 eggs, whence the larvae emerge in about 30 days at 20° C. After a week or so the larvae are ready to feed. They remain 2–7 days upon the host, as do also the nymphs which emerge from the larval skins after 30 days or so. The gorged nymphs, having in turn dropped from the host when fully fed, undergo metamorphosis upon the ground in 15 days at 24° C., when the adults, male and female, emerge. Both sexes attach themselves readily to the host, at first they scatter, but after 2–3 days pairs may be found attached close together. They copulate upon the host, the female usually taking 12 days to feed, whereas the male may remain attached for weeks. The female begins to oviposit after 3–5 days at 23° C. Under optimum conditions the life-cycle may be completed in 123 days.

Relation to Disease : *H. leachi* is the usual carrier of canine piroplasmosis in Africa, being distributed throughout the continent. It occurs most commonly on Carnivora, being specially noticed upon the dog. When a female tick feeds upon an infected dog the parasites undergo development in the tick and penetrate the ova. The ticks' offspring are not capable of conveying the disease until they attain sexual maturity.

In other words, infected larvae and nymphs are not infective, whereas the adults are. Infective adults, after having fasted up to seven months, have been placed upon a dog and produced fatal piroplasmosis after an incubation period of about 12 days. Piroplasmosis is the most deadly dog disease if left untreated. Trypanblue, as Nuttall and Hadwen have shown, cures nearly 100 per cent. of the affected animals if they receive an intravenous or subcutaneous injection of 10 cc. of a $1\frac{1}{2}$ per cent. aqueous solution of the drug at an early stage of the disease; it is common for apparently hopeless cases to recover. The chief symptoms of the disease are usually high fever, haemoglobinuria, jaundice, anaemia and a watery condition of the blood. The characteristic parasites, *Piroplasma canis*, are found in the blood corpuscles, which are largely destroyed, the number of parasitized corpuscles usually mounting steadily until death or recovery takes place.

Rhipicephalus appendiculatus is fairly widely distributed in Africa. It is a 3-host tick. The female lays 3,000–5,700 eggs which take 32–65 days to hatch at 17–19° C. The larvae remain usually 3–7 days upon the host, and, after dropping off, undergo metamorphosis to nymphs in 4–6 days at 30° C. The nymphs remain 5–11 days upon the host and afterwards require 10 days at 37° C. before they emerge as adults. The sexes copulate upon the host, the replete females dropping off after 6–14 days if fertilized, after 24 days when unfertilized. Oviposition commences 6–23 days after the female has dropped from the host, the process lasting 15–56 days. The males persist upon the host after the females have left. The sexes occur in about equal numbers.

The tick remains alive for a long time when unfed, thus larvae and nymphs survived over 333 and 164 days respectively and a single adult has survived over 682 days. The life-cycle, under laboratory conditions, may be completed in 115 days.

Relation to Disease: *R. appendiculatus* is the common carrier of Rhodesian Fever or East Coast Fever of cattle, caused by the protozoan blood parasite *Theileria parva.* The parasite is not transmitted hereditarily in the tick, but only from one stage to another; thus, if the larvae feed on infected cattle, the nymphs to which they give rise are infective, and similarly, if the nymphs become infected, the adults to which they give rise convey the disease to clean animals. Probably a tick or two suffices to produce infection; in one experiment conducted in Cambridge, seven adults produced the disease in a calf.

East Coast fever is ushered in by high fever occurring 10–17 days after the ticks are put on the animal, the characteristic parasites being found in the blood corpuscles 5–6 days later. The number of infected corpuscles steadily increases until death, which usually occurs 22–23 days after the ticks are put on. When cattle recover from East Coast fever they are no longer capable of rendering the ticks infective, this being contrary to what is observed in piroplasmosis (see p. 346).

Rhipicephalus capensis is a 3-host tick. The larvae and nymphs each abandon the host after sucking blood for about 5–8 days. Females remain on the host for 11–13 days, and begin to oviposit after about 5 days.

Relation to Disease: According to Lounsbury this tick may convey East Coast fever under experimental conditions. The tick conveys the parasite in a similar manner to *R. appendicalatus* and *R. simus*, as described above.

Rhipicephalus evertsi is a 2-host tick. When placed on the host as a larva it drops off as a gorged nymph after 10–14 days. The adults emerge after 22–25 days, at room temperature. The females remain 6–9 days upon the host.

Relation to Disease : According to Theiler, *R. evertsi* conveys equine piroplasmosis in the Transvaal. It remains to be determined which of the two parasites (*Piroplasma caballi*, Nuttall, or *Nuttallia equi* (Laveran) França) it conveys, since these parasites, which cause similar symptoms, were formerly confused. When the larva + nymph feeds upon an infected animal the adult tick is infective.

Rhipicephalus sanguineus occurs in many parts of the world in tropical and warm climates, being common upon the dog, but also occurring on other mammals. It is a 3-host tick, its life-history being similar to that of most other ticks in this respect. The female lays 1,400–3,400 eggs, which take 17–19 days to hatch at 30° C. The larvae and nymphs remain usually four days upon the host and take 5–8 and 11–12 days respectively to undergo metamorphosis to nymphs and adults. The female stays upon the host 7–21 days before she is replete. Copulation takes place upon the host, the males remaining for an indefinite period after the females have dropped off. The females begin to oviposit 3–6 days after they have fallen to the ground. The males are more numerous than the females.

This tick shows marked longevity when unfed ; thus under laboratory conditions larvae survived 253 days, nymphs 97 days and adults over 570 days. Under optimum conditions the life-cycle may be completed in 63 days at 30° C.

Relation to Disease : *R. sanguineus* has been shown to be the carrier of canine piroplasmosis in India and it doubtless occasionally conveys the disease in Africa and elsewhere. In Africa the chief carrier has been shown to be *Haemaphysalis leachi* (see p. 343). In the case of *R. sanguineus*, however, the parasite behaves differently from what it does in *H. leachi*, for nymphs descended from infected females and adults emerging from nymphs fed upon a dog suffering from piroplasmosis are capable of producing the disease in other dogs upon which they attach themselves (Christophers).

Rhipicephalus simus, is a 3-host tick, with a life-history similar to that of *R. appendiculatus*.

Relation to Disease : *R. simus* conveys Rhodesian fever to cattle, but it is not the common carrier. The parasites are not hereditarily transmitted in the tick ; it is a case of stage to stage infection, as in *R. appendiculatus*, which is the usual carrier (see p. 344). In both species the infected ticks cease to be infective after feeding, in other words they " clean themselves."

Boophilus decoloratus occurs throughout tropical and southern Africa. It is a 1-host tick. When placed upon the host as a larva it rarely drops off until it reaches the adult stage. The females drop off 22–34 days after the larvae have been put on the host, and during this period all stages of development may be observed upon the infested animal. After the larvae gorge they adhere to the host's skin, undergo metamorphosis *in situ*, and emerge as lightly chitinized nymphs, which immediately re-attach themselves and in turn proceed to feed to repletion. When

gorged, they remain *in situ*, undergo metamorphosis in turn and emerge as adults, which promptly re-attach themselves. Copulation takes place upon the host. The females lay some 1,000–2,500 eggs.

This tick does not live long unfed, the larvae scarcely survive 90 days' starvation and the other stages perish rapidly when removed from the host. The life-cycle from egg to egg may be completed in 25 or more days.

Hosts : cattle, although the species is occasionally found on other mammals.

Relation to Disease: B. decoloratus commonly conveys bovine piroplasmosis throughout tropical and southern Africa, this disease being caused by *Piroplasma bovis* (= *bigeminum*) which multiplies in the blood corpuscles of cattle. When a female tick imbibes blood containing this parasite she transmits it to her larval offspring. Cattle usually show fever about 10 days after infestation with infected larvae. The parasites now appear in the host's blood and re-infect the ticks as they attain maturity.

Apart from fever, the affected cattle commonly show progressive emaciation, anaemia, bloody urine, etc., as in dogs suffering from piroplasmosis (see p. 344), the blood grows watery and the spleen becomes much enlarged. The mortality from the disease may be very high, 40–100 per cent. of the affected animals, chiefly freshly imported cattle, not infrequently dying. The persistence of the disease in nature is explained (as in equine and canine piroplasmosis) by the fact that when cattle recover they may continue (whilst apparently in perfect health) to harbour the parasites in their blood for years. The apparently immune indigenous cattle are really all infected and serve as " reservoirs " for the *Piroplasma*, which are taken up by the *Boophilus*.

Piroplasmosis in cattle may be successfully treated by the intravenous injection of 200 cc. of a 1·5 per cent. aqueous solution of trypanblue (Nuttall and Hadwen). Animals which have recovered under this treatment are in the same condition as " salted " animals, i.e., those that have recovered under natural conditions. Cattle treated with trypanblue (as also dogs) continue to harbour the parasites in their blood.

Eradication: This is the tick which has been most successfully eradicated by dipping processes and changing the pasturage of susceptible animals. Many thousands of square miles have been rid of the tick and the disease by these measures in the United States, South Africa and Australia.

Hyalomma aegyptium occurs throughout Africa, in Southern Europe and many parts of Asia, notably in India. The tick may require either two *or* three hosts. The female lays 10,000 to 15,500 eggs, which take 35 days to hatch at 18° C. The larvae become engorged in 4–15 days, when they frequently drop off to undergo metamorphosis; others may, however, whilst remaining attached to the host, undergo metamorphosis *in situ* and emerge as nymphs, which quickly re-attach themselves, and, after feeding to repletion, drop to the ground to undergo metamorphosis to adults. Where the larvae and nymphs remain attached to one host, the gorged nymphs drop off 25–46 days after they were put on the animal as unfed larvae. Females remain 6–8 days upon the host, whereas the males may remain anchored for months in the same spot where they previously copulated. There are about three times as many females as there are males.

Unfed larvae kept in tubes in the laboratory were lively after 369 days ; nymphs scarcely live more than 90 days, whereas adults live much longer. A couple of females, after fasting 817 days, have been fed on a sheep and been put with males which had fasted 210 days ; these females produced offspring in due course. The life-cycle may be completed in 116 days.

Hosts : cattle, sheep, horses, and many other animals, both wild and domesticated.

Relation to Disease : *H. aegyptium* has not as yet been shown to convey any disease, but we suspect that it may carry *Nuttallia equi*, one of the two species of *Piroplasma*-like parasites causing " biliary fever " in horses. The suspicion is based upon the agreement between the geographical distribution of the blood parasites and the tick in Africa, Southern Europe and Asia. The subject is at present being investigated experimentally in Cambridge.

The effects of the bite may be troublesome.

Amblyomma hebraeum. The only two species of African *Amblyomma* whose life-histories are known are *A. hebraeum* and *A. variegatum*. The latter appears to have no pathogenic significance ; it has the same habits as *A. hebraeum* in requiring three hosts upon which to feed in the larval, nymphal and adult stages. A female *A. hebraeum* may lay up to 18,500 eggs in 8–11 days at 30° C., the process lasting longer at lower temperatures. The eggs, laid upon the ground, hatch after about 50 days and in about a week the larvae are ready to feed. They attack a variety of hosts, and, dropping off gorged after five or more days, undergo metamorphosis in about 12 days, when the nymphs cast off the larval skin. The nymphs are ready to feed in about a week, remain usually six days upon the host, and, when replete, drop to the ground. The adults, male and female, emerge after about 18 days. The males are more numerous than the females and the latter do not readily attach themselves to the host unless they find males already attached. Copulation takes place upon the host, the female swelling up to a great size (about 3 cm. in length) and abandoning the host after about 6–12 days. The female after hiding herself in the ground, begins to oviposit in 8–74 days, according to the temperature. The males may remain anchored upon the host for 41–355 days awaiting a fresh female. Under optimum conditions in the laboratory the life-cycle from egg to egg has been completed in 171 days.

Relation to Disease : So far as known, *A. hebraeum* is the only species of *Amblyomma* which conveys disease. It is dreaded in South Africa because it carries " Heart-water," a frequently fatal disease in sheep, goats and cattle, due to an undetermined, probably ultramicroscopic, organism. The disease and the tick are confined to Africa. When the tick feeds as a larva or nymph upon an infected animal it transmits the disease after attaining the nymphal or adult stage respectively (Lounsbury).

Apart from this the tick causes a considerable amount of trouble by its bites, which may cause swelling and lead to suppuration.

Eradication : This tick has been successfully eradicated in parts of South Africa by the frequent application of the dipping process. The tick resists starvation for long periods, thus laboratory experiments have shown that unfed larvae may survive for 346 days, nymphs for 250 days, adults for upwards of two years. The adults may remain attached to a dead host until they die.

Collecting Ticks.

Ticks are usually collected from the hosts which they infest. These hosts may be mammalia, birds, reptiles (snakes, lizards, tortoises) or amphibia (toads). They may also be captured on vegetation or on the ground, although they are less frequently found in this way unless they are numerous. An easy way of collecting specimens in the latter case is to drag a piece of rough flannel or similar cloth (preferably white) across the surface of the ground or vegetation. They promptly cling to the cloth and can then be picked off and put into pill-boxes or tubes. *Ornithodorus moubata* will be found in native huts in the dust or mud cracks in the floor and walls, and in the thatch near sleeping places. They also occur in the dust at resting places along routes of travel.

When ticks are attached to a host, care should be taken in removing them, otherwise the mouth-parts may be broken off and the specimens damaged. They are best removed by seizing the base of the capitulum with a small pair of forceps and rotating slightly whilst pulling it out gently. If firmly embedded, a drop of any oil smeared on the tick will facilitate matters. Ticks with injured mouth-parts are usually of little use for study and females thus injured frequently fail to lay eggs. Larvae are removable by scraping the skin with a knife blade, their mouth-parts being smaller and less deeply embedded than in the other stages. Ticks with long sharply toothed hypostomes, especially species of *Ixodes*, are difficult to remove without injury. If great difficulty is experienced in loosening the ticks from a dead host, the piece of skin to which the tick is attached may be cut off and the tick subsequently removed if it does not come off of itself.

All ticks from one species of animal from one locality may be placed in the same tube, but care should be taken not to mix the ticks taken from different hosts in the same locality. It is especially important to keep ticks from different localities separate.

Killing and preserving ticks.—When possible, it is best to kill ticks by dropping them into small corked glass tubes containing 25–30 per cent. alcohol to which 2–3 drops of ether have been added. Ticks thus treated die with their legs extended, which facilitates their examination. After 24–48 hours the specimens should be placed in 60 per cent. alcohol, which is the best and simplest preservative and may be used directly if the weaker alcohol and ether are not available. Stronger alcohols harden the specimens and render them too brittle for convenient examination; the same objection applies to formalin solutions. Failing alcohol, ticks may be preserved in brandy, whiskey or gin. Too many specimens should not be crowded into a tube. If alcohol is not procurable and the atmosphere is dry, the ticks may be allowed to die in tubes or pill-boxes containing folded tissue paper (not cotton wool) or the specimens may be transfixed by fine entomological pins, as is commonly done with insects; such specimens are however very liable to injury and require careful handling and packing.

Labelling specimens.—It is most important that specimens should be adequately labelled. Write *legibly* with a sharp and moderately soft (H.B.) lead pencil on good white paper and place the label *inside* the tube. State the name of the host (scientific name if possible), give the *date* and *place of collection* and the *collector's name*. If

further particulars are supplied regarding the ticks, i.e., their habits, frequency, relation to disease, etc., these should be noted on a separate sheet with a number corresponding to that given to the tubed specimens. Special care should be taken to write the names of localities and of the collector very clearly.

Packing specimens.—Tubes should be tightly corked and, if possible, the corked ends should be dipped in melted wax or stearine as an extra safe-guard against evaporation. Tubes should be well filled with alcohol. Each tube should be rolled up in a separate piece of paper and surrounded with a layer of cotton wool ; this for the reason that if the tube breaks the ticks remain inside the paper and the wool absorbs the escaped alcohol. Failing wool any other vegetable fibre or even saw-dust may be used. Pack tubes in strong wooden boxes.

What to collect.—All stages of ticks should be collected. It is not always the largest (females) that are most interesting. Remember that the male is small, and is frequently found attached close to the female. Nymphs and larvae may be very small and frequently escape the eye of the collector whose attention is most often attracted to the engorged females to the exclusion of the other stages.

What to observe.—Note the place upon the body of the host where the ticks occur, and note the behaviour of the sexes. In birds they are commonly attached about the head ; in mammals they are attached to the skin in places where it is thin or there is less hair (about the anus, udder, genitalia, in folds of soft skin, about the ears, etc.). It should be noted if the animals from which the ticks are taken show any symptoms of disease or show protozoal parasites (*Piroplasma,* etc.) in their blood.

When uncommon species are collected whose life-history is unknown, assuming that gorged and fecundated females are available, it is very desirable that an attempt should be made to raise the species through its various stages. Even if complete success does not follow, some valuable information may be obtained from a partial life-history. With the object of aiding those who may attempt to raise ticks experimentally we append a short account of the methods which may be adopted.

How to Raise Ticks.

We shall assume that the investigator has secured one or more fully gorged and fecundated females which have abandoned the host of themselves, or which have been very carefully removed so that their mouth-parts have not been subjected to injury.

Gorged females must be handled gently, otherwise they will die. They should be placed in wooden pill-boxes, each female in a separate box appropriately marked. If the atmosphere is dry, a modicum of moisture may be supplied by placing the boxes on dampened soil or sand in a covered or uncovered vessel. The boxes should be opened daily for inspection, care being taken not to disturb the females more than is absolutely necessary. Keep accurate records of events ; the date and host, etc., from which the ticks were collected, and the time when oviposition begins and ends, and when the female dies. As the eggs accumulate, they may be removed to a corked tube bearing a corresponding number to that of the female which supplied the eggs. By covering the cork with filter paper inside the tube and allowing some of the paper

to protrude the latter may be periodically moistened (if needed) with a drop of water. Note when the first eggs were laid and when the first larvae emerge. Preserve some of the larvae in alcohol.

A week or more after larvae have emerged place them upon some small animal which is available and capable of supporting captivity. Hedgehogs (*Erinaceus europaeus*) have been found by us to be very suitable for raising many ticks infesting mammals in Europe and Africa, because the bristles on the animal prevent its scratching off the ticks. The host (dog, guinea-pig, etc.) should be placed in a metal cage which can readily be subjected to daily inspection and which is provided with a coarse net-work floor through which gorged ticks may drop into a tray underneath. Sheets of white paper, laid upon the tray every day, greatly facilitate the finding of small gorged ticks (larvae) which may drop from the host. The whole cage should be placed in a white-painted tray surrounded with a gutter containing water which effectually prevents the escape of ticks. Inspect the tray daily and note when the first gorged larvae are collected. The larvae are readily picked up by means of a fine camel's hair brush and they should be transferred to corked tubes similar to those in which the eggs were kept. Count the number of gorged larvae which are collected daily and enter the numbers upon the records. Having noted when they dropped from the host, the next thing to record is the date of their emergence as nymphs. The nymphs will require a week or more before they are ready to feed upon a host. The process described for the larvae is repeated by the nymph and finally the adult stage is attained.

The adults, and for that matter the larvae and nymphs in some cases, can also be conveniently raised upon larger animals if these are available. The unfed ticks are then placed in strong white linen bags which can be tied about the ears (cattle and horses) or scrotum (ram, goat, bull). The bags should be then periodically inspected and the gorged ticks removed.

The length of time occupied in metamorphosis from egg to larva, larva to nymph and nymph to adult is much influenced by temperature, consequently a daily record should be kept of the temperature at which the ticks are maintained when undergoing the change. The behaviour of the sexes upon the host should be noted, as well as the proportionate numbers of each sex which emerges from a given number of nymphs. The number of eggs laid by each female may be estimated with considerable accuracy by suspending the eggs in water and spreading them out in a uniform layer within a square frame made of strips of glass fixed upon a sheet of glass of suitable size. Count the eggs in a row on two sides of the square and multiply these numbers to obtain the total number of eggs.

Although these directions suggest that the raising of ticks under experimental conditions is a simple matter, this is frequently not the case in practice. Some ticks have not been raised by us, though repeated attempts have been made under various conditions, and others have been repeatedly raised through several generations without any particular difficulty. We do not know the cause of our failures in some cases, whereas in others we have traced it to unsuitable conditions of moisture and temperature. Some ticks must be kept dry, others in a slightly moistened atmosphere, others again in a saturated atmosphere during metamorphosis. Moulds are a fruitful source

of trouble in the latter case. The optimum temperature for the development of ticks received from tropical countries appears to be about 32° C., whereas ticks occurring in temperate climates appear to undergo metamorphosis most rapidly at a temperature approaching 20° C. It is well to determine which is the most suitable host upon which to raise a species. Long-haired hosts are best.

We wish to make it clear that to raise ticks successfully may at times be a matter of great difficulty. It is naturally much easier to raise 1-host ticks than 2-host ticks, and more difficult to raise 3-host ticks, because of the increased loss of life during metamorphosis, especially under artificial conditions.

It is clear that a sound knowledge of the life-history of the disease-bearing ticks is essential in connection with the study of the diseases they convey and that such knowledge is of great practical utility in the application of effective measures of prevention.

Index to Congo Ticks and their Hosts.

For Notes see end of Index.

INDEX TO CONGO TICKS AND THEIR HOSTS—*cont.*

* Denotes species which convey diseases and whose life-histories are described in the text.
† Names in italics are those of hosts from which we have received most specimens.
‡ Life-history described in the text.

THRIPS ORYZAE, SP. NOV., INJURIOUS TO RICE IN INDIA.

By C. B. Williams, B.A., F.E.S.

(*The John Innes Horticultural Institution, Merton, Surrey.*)

Up to the present time no single species of the cosmopolitan genus *Thrips* has been recorded from the mainland of India. In fact our knowledge of the Thysanoptera of this country is extremely fragmentary. Schmutz in 1913 (Sitzb. der K. Akad. Wissensch. in Wien, Math-nat. kl. cxxii, p. 1–99) described forty-four species from Ceylon, and since that time about a dozen more have been added, and no doubt many of these will be found to occur on the mainland. At present, however, only seven species are recorded. These are: *Physothrips lefroyi*, Bagnall, *Physothrips usitatus*, Bagnall, *Heliothrips indicus*, Bagnall, *Panchaetothrips indicus*, Bagnall, *Hindsiana apicalis*, Bagnall, *Phoxothrips breviceps*, Bagnall, and *Leeuwenia indicus*, Bagnall. It is probably no exaggeration to say that there are at least two thousand species in that country still awaiting discovery.

The present species *Thrips oryzae* is reported by Mr. E. Ballard, the Government Entomologist at Madras, to be injurious to young rice. It comes in that section of the genus *Thrips* with the head almost as long as wide, and with a more slender prothorax. Many of this section have been placed at times in the genus *Bagnallia*, but the line of separation of these forms from those with broader heads is so indistinct that the erection of another genus for them only causes further difficulty. I propose that, for the present at least, *Bagnallia* be considered as a subgenus of *Thrips*.

The genus *Thrips* is in almost greater confusion than any other genus of this order, many species having been badly described by writers without reference to known species. The only course under the circumstances is to describe the species below as new, and so that it can be recognised, and to wait for the time when the rediscovery or rejection of certain forms makes a revision of the whole genus possible.

Thrips (Bagnallia) oryzae, sp. nov. (fig. 1).

Female (macropterous).

Measurements: Head, length 0·110 mm., width 0·120 mm.; prothorax, length 0·130 mm., width 0·146 mm.; pterothorax, length (mid dorsally) 0·172 mm., width 0·208 mm.; 9th abdominal segment, length 0·080 mm.; 10th segment, length 0·052 mm.; wing, length 0·66 mm., width 0·046 mm.; total body length 1·04 mm.

Antennae, segment	1	2	3	4	5	6	7
length (μ) ..	21	31	36	30	29	37	19
width (μ) ..	27	27	19	18·5	18	18	8

Total length of antenna 0·210 mm.

Colour. Body uniformly dark brown; legs similar, except for the fore tibiae and all tarsi, which are paler but still brown; antennal segments 1 and 5–7 dark, 2 and 4 paler, 3 still paler; ocellar pigment reddish brown. General form slender.

Head (fig. 1, *a*) about one-tenth wider than long, the sides almost parallel, cheeks not arched. *Eyes* not large, very slightly projecting, distance between the eyes about one and a half times the width of the eye; distance from the eye to the back of the head about one and a quarter times the length of the eye. *Ocelli* forming a slightly

obtuse-angled triangle, the anterior ocellus directed forward. Ocellar spines short and weak, outside the line joining the anterior and posterior ocelli ; a longer spine on the frons near the margin of each eye ; a spine behind each posterior ocellus, and a row of one long and about three short ones behind each eye. The hind part of the head distinctly striated ; the hind margin heavily chitinised. The *mouth-cone* very long, reaching right across the prosternum. The *maxillary palps* rather long, three-segmented, the basal segment the longest ; relative lengths of the segments approximately 8 : 4 : 6 ; about four sense hairs at the apex of the third segment.

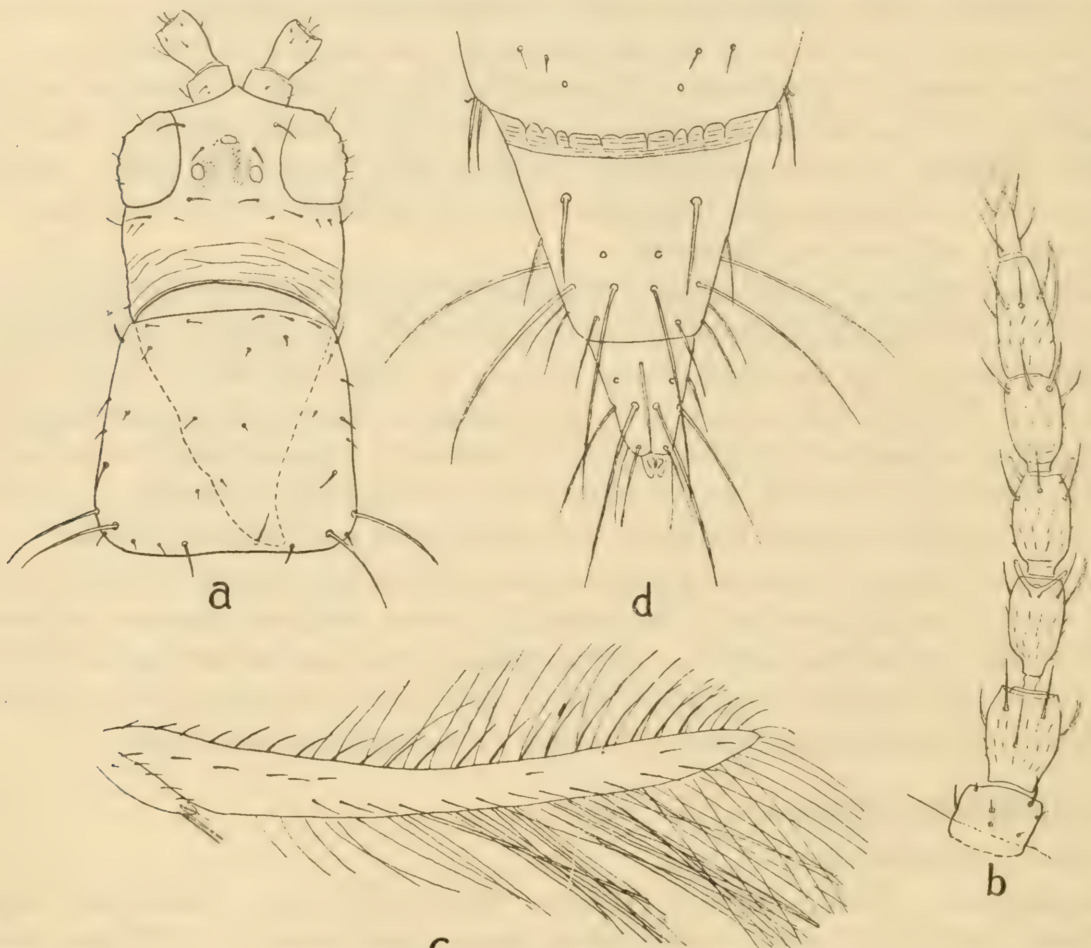


Fig. 1. *Thrips oryzae*, Williams, sp. n. ; *a*, head and prothorax ; *b*, antenna ; *c*, fore wing ; *d*, apex of abdomen, dorsal view.

Labial palps two-segmented, the basal segment very short. *Antennae* (fig. 1, *b*) not quite twice as long as the head, rather stout. The first segment short and broad ; the second almost as wide but longer, tapering at each end, but more so at the base ; the third much narrower and with a distinct pedicel ; the fourth a little shorter than the third, rapidly constricted just above the base ; the fifth with a broad apex and constricted at the base as in the fourth ; the sixth as long as or very slightly longer than the third (with the pedicel) ; the seventh half as long as the sixth and twice as broad as long. Forked trichomes on the third segment dorsally and the fourth ventrally. Colour : the first, fifth, sixth and seventh segments uniformly about as dark as the body, the second and fourth a little paler, particularly the apex of the former, the third still a little paler, especially towards the base.

Prothorax (fig. 1, *a*) about one-fifth longer and wider than the head. Two long spines at each hind angle ; three short ones on each side of the hind margin, the innermost longer than the others ; the anterior marginal spines not noticeably longer than the small spines which are scattered over the pronotum. *Pterothorax* normal, the meso-scutum twice as long as the scutellum. *Legs* normal, fore tarsi unarmed ; as dark as the body, except the tarsi and fore tibiae, which are very slightly paler. *Wings* fully developed, pointed at the tip, fore wing (fig. 1, *c*) about 14 times as long as wide at the middle. Veins in the fore wing very indistinct. On the costa 21–24 spines ; on the fore vein 5–7 near the base and 3 in the outer portion, the proximal one somewhat widely separated from the other two ; on the hind vein 11–13 ; the spines are long and pointed, particularly on the outer half of the costa. The costal fringe commences about one-third the wing length from the base. The posterior fringe at its greatest length is about six times the breadth of the wing. Colour uniformly dark brown, except for an elongate paler fleck near the base ; all spines on the wing dark. Hind wings also brown in colour, but paler than the fore pair ; the longitudinal vein very distinct and reaching almost to the tip of the wing.

Abdomen slender ; the ninth segment long, 1·6 times as long as the tenth (fig. 1, *d*) ; terminal spines slender. A row of short pointed teeth on the hind margin of the eighth tergite, usually incomplete mid-dorsally.

Numerous females (no males) taken "on very young paddy (*Oryza sativa*), Madurantakam, S. India, 2nd–7th May 1915, by T. V. Ramakrishna Ayyar."

Type in the British Museum.

The chief characteristics by which this species may be recognised are the slender head and prothorax, the long mouth-cone, the dark wings and the long ninth abdominal segment. It may even be necessary at some future time to separate it from the bulk of the genus *Thrips*, more particularly if forms resembling it are found when the Indian fauna is better known, but for the present it comes nearest to this group and is best left with them.

The material sent included a number of short pieces of young rice stems imbedded in which were a number of *eggs* of this thrips ; they are of the usual kidney shape and are 0·25 mm. long and 0·10 mm. broad.

Numerous *larvae* were also present, pale yellowish white in colour, with slightly darker legs, head and antennae. *Pupae* and *prepupae* differed in having the legs and antennae paler than the body and in having four long pointed processes from the hind margin of the ninth tergite. The prepupae have, as is usual in the group, the antennae free and short wing cases reaching about one-third the length of the abdomen ; the pupa has the antennae applied to the dorsal surface of the head and the wings reaching over two-thirds the length of the abdomen.

The only other thrips so far recorded as damaging rice are two species of a different suborder (TUBULIFERA) from Japan, described by M. Matsamura (Annot. Zool. Japan, iii, 1899, pp. 1–4). They are *Haplothrips* (nec *Phloeothrips*) *oryzae* and *H. japonica*. They may be easily separated from the present species by the abdomen ending in a tubular tenth segment without any ovipositor.

EIGHT NEW MOSQUITOS IN THE BRITISH MUSEUM COLLECTION.

By F. W. Edwards, B.A., F.E.S.

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Ochlerotatus oreophilus, sp. n.

♀. *Head*: sides clothed with flat white scales, interrupted by a rather narrow horizontal band of flat black ones; two large patches of flat black scales on the top, separated by a rather narrow band of narrow white scales extending from the nape on to the front; a narrow line of narrow white scales bordering the upper part of the eyes. Eyes well separated. Proboscis and palpi black. First antennal joint blackish, grey-pruinose. *Thorax*: integument blackish, except for the reddish scutellum and a small pale spot on each side at the base of the postnotum. Prothoracic lobes and the space behind them clothed with flat white scales. Scutum clothed with narrow yellowish-white and blackish scales, the former arranged in definite narrow lines as follows: a median line extending from the front margin to a little in front of the scutellum, where it forks into two; a line on each side of this extending the whole length of the scutum, enlarged a little in front of the middle and sending a branch obliquely forwards from this point to the lateral angle of the thorax; and another line forming a border to the scutum. Scutellum with narrow scales, mostly yellowish-white, but some black ones on each side of the middle lobe. Pleurae with several patches of flat white scales. *Abdomen* black, above with conspicuous pure white basal lateral patches and traces of yellowish-white basal bands on all the segments; venter black, all the segments with pure white basal bands. Eighth segment well-developed, only partly retractile; cerci short, rather broad and rounded at the tip.

Legs black; front and middle femora with a white line beneath, middle femora also with a distinct white spot at the tip in front; hind femora white with a broad complete black ring a little before the apex, broadest above. Middle claws toothed, hind simple (front tarsi missing). *Wings* with blackish scales, rather densely covered; scales of the lateral series on the apical third of the wing rather broadly linear, with bluntly rounded tips. Base of upper fork-cell a little nearer the base of the wing than that of the lower; cross-veins separated by about $1\frac{1}{2}$ times their own length. Halteres light brown, knob with dark scales on the inner, light on the outer side.

Length of body, 5·5 mm.; of wing, 4·5 mm.

N. India: Gharia, Murree Hills, W. Himalayas, 16. viii. 190.

A single female specimen, presented to the British Museum by the Agricultural Research Institute, Pusa.

This species may be readily distinguished by the thoracic and femoral markings. It belongs to a group which is rather numerously represented in Asia, especially in the mountainous regions, and includes such species as *O. pseudotaeniatus*, Giles, *O. macfarlanei*, Edw., *O. japonicus*, Theo., and *O. pulchriventer*, Giles; the group roughly corresponds to Theobald's genera, *Pseudohowardina* and *Hulecoetomyia*, and it may be possible eventually to revive one of these names for it. The nearest ally of the new species is perhaps *O. pulchriventer*, Giles; it differs in the points indicated.

Ochlerotatus eatoni, sp. n.

Culex eatoni, Theobald, M.S.

♂. *Head* and *thorax* coloured and scaled as in *O. oreophilus*, except that the integument of the scutellum is dark, while that of the postnotum is blackish-brown with a more distinct pale lateral stripe towards the base ; the pale thoracic lines are composed of golden-yellow rather than creamy-white scales and are rather less distinct ; the two outer of the three longitudinal lines are narrowly interrupted just in front of the point from which arises the branch running to the lateral angle. Palpi only two-thirds as long as the proboscis, black, two last joints moderately hairy, the penultimate about half as long again as the terminal. *Abdomen* black, the segments with large silvery-white basal lateral spots, continuous with narrow dull white basal bands ; venter black, the segments with pure white basal bands. *Genitalia* : side-pieces more or less cylindrical, nearly straight, without basal or apical lobes, some long dark hairs above and numerous very long yellow ones below ; clasper flattened except towards the tip, curved, with a long terminal spine ; harpagones with the terminal appendage very long, curved, bristle-like. *Legs* : all the femora black above, white below except towards the tip, the white not extending quite so far on the hind femora ; middle and hind femora with a small whitish spot at the tip ; tibiae and tarsi entirely black ; larger claw on fore and mid feet with basal and median teeth, the smaller with median tooth only ; hind claws simple. *Wings* with blackish scales which (towards the apex) are almost linear ; bases of fork cells about level. Halteres with yellow stem and black knob.

Length 5 mm. ; proboscis 3 mm.

Madeira Is. : Monte Funchal, 2,000 ft., 7.iii.1902 (*Rev. A. E. Eaton*).

One male presented to the British Museum by the collector.

Although from widely separated localities, this species and the preceding seem to be very closely allied ; the difference in leg-markings however will sufficiently distinguish them ; it is unfortunate that we have only the male of *O. eatoni* and only the female of *O. oreophilus*. Of previously described species the one which most resembles *O. eatoni* is the Himalayan *O. pulchriventer*, Giles, which differs principally in the absence of distinct markings on the thorax and in its remarkable male genitalia, which resemble those of the American genus *Haemagogus*.

Culex nilgiricus, sp. n. (fig. 1).

♂ ♀. *Head* with dark brown upright scales ; creamy-white flat and narrow curved ones at the sides and in the middle respectively ; the whitish more numerous in proportion to the dark brown ones in the male than in the female, and the flat ones extending higher up ; the flat ones tend to form a line round the upper part of the eye margins, but in neither sex do they actually reach the middle line. A row of dark bristles round the eyes, of which a pair on the vertex are much longer than the others, at least in the female. Palpi and proboscis entirely black-scaled in both sexes ; male palpi longer than the proboscis by their terminal joint ; basal segment without any row of projecting scales, but with some pale shortish hairs and with a few long dark ones towards the tip ; second and third joint with numerous long dark hairs, the second nearly five times as long as the labella, the third about one-quarter longer

than the second. *Thorax*: prothoracic lobes reddish brown, apparently without scales; scutum (mesonotum) reddish brown, slightly pruinose, clothed with reddish brown scales; scutellum pale, almost whitish, clothed with narrow pale brown scales; postnotum light reddish brown. Pleurae almost uniformly pale, unscaled. *Abdomen* blackish brown above, the segments with white basal bands of even width, broader in the male than in the female; venter almost uniformly pale. *Male genitalia*: side-pieces of the usual *Culex* form without special modification, leaf-like appendage very narrow. Claspers (fig. 1) moderate, smooth, gently curved, rather abruptly narrowed a short distance before the tip (as in *Culiciomyia*), a single fine hair arising from the point of narrowing. Unci with pointed tips. Harpagones apparently

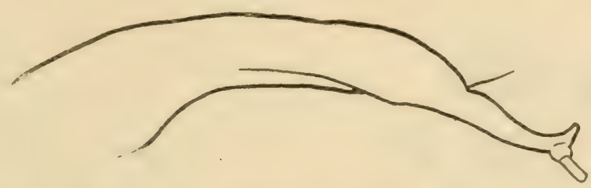


Fig. 1. *Culex nilgiricus*, Edw., sp. n.; clasper of male genitalia.

undivided, but provided with a rather long, pointed, downwardly extending projection, somewhat jagged on its lower edge (as in *Culiciomyia*). Harpes short and broad, without basal projection, their tips broad and provided with shorter and less numerous spines than usual. *Legs* dark-scaled, the under sides of the femora lighter; claws on the four anterior legs of the male each with a well-marked tooth. *Wings* rather thinly clothed with dark scales, those in the lateral series linear, few in number, except towards the tip of the wing. Fork-cells very long, yet scarcely twice as long as their stems, the upper with its base slightly nearer the apex of the wing than that of the lower. Cross-veins separated by about twice their own length. Halteres light brown.

Length of body, 6 mm.; ♂ wing, 4·5 mm.; ♀ wing, 5 mm.

MADRAS: Utakamand, Nilgiri Hills, 7,500 ft., 24–31.xii.1913 (*T. Bainbrigge Fletcher*).

1♂ 1♀ presented to the British Museum by the Agricultural Research Institute, Pusa.

I have placed this species in *Culex* owing to the apparent absence of the long outstanding scales of the male palpi and the fact that the flat scales on the head do not reach the middle line round the eyes; nevertheless it shows unmistakable affinities in its genital characters with the *Culiciomyia* group. In general appearance also it has an extremely close resemblance to *Culiciomyia viridiventer*, Giles, known from several localities in the Himalayas; apart from the characters just mentioned this species differs chiefly in the male genitalia, which in *C. viridiventer* are much more specialised. In view of the discovery of this species it is more than ever doubtful whether the genus *Culiciomyia* can be maintained.

It is worthy of note that a *Culex* with spotted wings was taken by Mr. Fletcher in the same locality which proved to be the true *C. mimeticus*, Noé, and not the recently distinguished *C. mimulus*, Edw., proving that both these species occur within the Oriental region.

Culex ingrami, sp. n. (figs. 2, 3).

Differs from *C. invidiosus*, Theo., only in characters of the male genitalia. The side-pieces and their appendages rather closely resemble those of *C. invidiosus*, but the clasper is more evenly narrowed towards the tip. The unci are rounded at the tip, the harpagones divided into two portions which have a very peculiar form; neither of them is toothed or subdivided. The harpes have the usual crown of spines, but instead of a finger-like basal projection they have a large blunt prominence.

Ashanti: Sunyani, 1♂ 3♀ bred from larvae (*Dr. A. Ingram*).

One male and two females presented to the British Museum by the Imperial Bureau of Entomology.

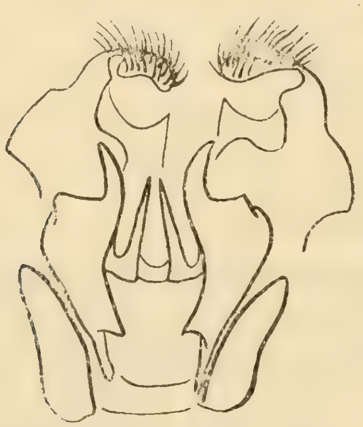


Fig. 2. *Culex ingrami*, Edw., sp. n.; male genitalia.

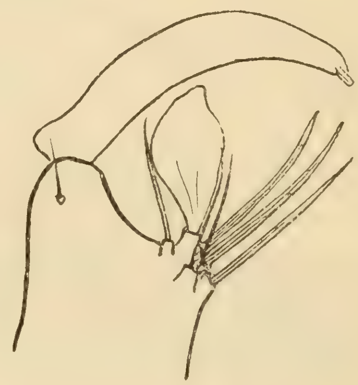


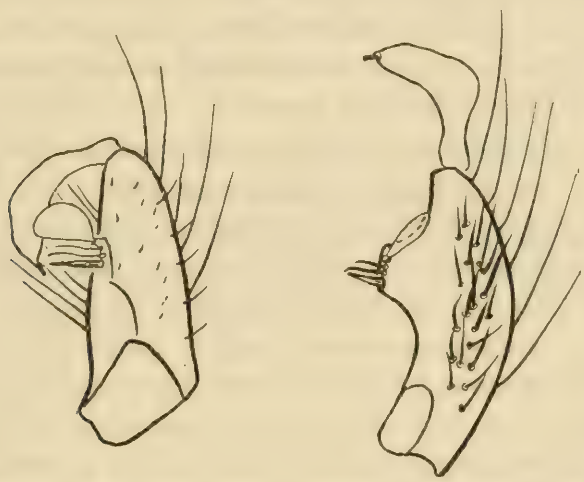
Fig. 3. *Culex ingrami*, Edw., sp. n.; left clasper of male.

Although in general characters this species exactly resembles *C. invidiosus*, its genitalia are much more like those of *C. pruina*, Theo.; there are however good specific differences. Dr. Ingram has obtained and distinguished larvae of all three forms at Sunyani, and we have here therefore another interesting case of the correlation between larval and male genital characters.

Culex pacificus, sp. n. (fig. 4).

♂. *Head.* Integument blackish, clothed with scales of the usual form: flat whitish scales at the sides, narrow dark brown ones above; upright forked scales light brown in front, dark brown behind. Proboscis not quite as long as the abdomen, black-scaled for the most part, but with a narrow and ill-defined pale ring just beyond the median suture, most distinct on the under side. Palpi longer than the proboscis by the length of their last joint; long hairs on the last two joints few in number; scales mostly black, but small patches of whitish ones at the bases of the last two joints on the under side, sometimes just passing round to the upper side. *Thorax*: integument blackish; scales of scutum mostly dark brown, but there are a pair of roundish patches of black ones towards the front; and a suggestion of a pair of paler lines on the posterior half; scales of scutellum lighter. Pleurae with some inconspicuous flat whitish scales. *Abdomen* black, the segments with white basal bands of even width; ventrally the segments have broad black apical bands. *Genitalia*: the side-pieces are straighter than in most species of *Culex*, with long dark hairs above, and a patch

of yellowish ones on their latero-ventral surface ; the lateral projections bearing the usual leaf-like appendage, together with a spine and two hairs ; claspers very large and broad, bent almost at an angle about the middle. Basal parts somewhat resembling those of *C. trifilatus*, Edw., the harpagones being divided into three untoothed parts. *Legs* black, tarsi not ringed ; under side of hind femora pale ; small patches of pale ochreous scales at the tips of the femora and of the front and middle tibiae, and a larger patch forming a very distinct pale spot at the tip of the hind tibiae. Claws of the front and middle legs each with a single tooth. *Wings* with blackish scales, those in the lateral series linear. Base of upper fork-cell nearer the base of the wing than that of the lower ; cross-veins separated by nearly twice the length of the lower. Halteres brownish.



a **b**

Fig. 4. *Culex pacificus*, Edw., sp. n. ; male genitalia ; *a*, left side-piece, inner lateral view ; *b*, right side-piece, outer latero-ventral view.

♀. Much resembles the male, apart from sexual differences, but there is practically no sign of a pale ring on the proboscis, even on the under side. There is the usual variation in the abdominal markings, the pale bands sometimes appearing to be absent ; when present their posterior edges are straight, not rounded.

Length (without proboscis) about 4–4·5 mm.

New Hebrides : Port Vila, Zagabé, and at the French Hospital.

About 60 specimens sent by the French Government to the Imperial Bureau of Entomology, who have presented a series to the British Museum.

The species differs from *C. fatigans* in the general black colour and smaller size, in the presence of a more evident pale ring on the proboscis of the male, in the much more distinct pale spot at the tip of the hind tibia, and in the very different male genitalia. The general appearance is suggestive of *C. sitiens* or *C. jepsoni*, but the tarsi and the female proboscis are without pale rings.

Eretmopodites dracaenae, sp. n.

♂♀. *Head* clothed with metallic silvery-blue scales, a small patch of upright forked scales on the nape which are mostly yellow, a few towards the front being black. Proboscis and palpi black-scaled. *Thorax* with yellow integument; prothoracic lobes clothed with bluish-silvery scales. Scutum clothed with narrow orange and black scales, the black ones arranged as follows: a few on the area behind the prothoracic lobes; a pair of stripes commencing at the base of the wing and extending half-way from there to the front margin; a second pair internal to these and extending from the scutellum almost to the front margin, widening out a little in front of shorter outer stripes, without quite coming into contact with these; an ill-defined median black stripe on the anterior half of the scutum, divided into two by a double row of orange scales which lie immediately on each side of the middle line. Lateral lobes of scutellum clothed with narrow scales, outwardly orange and inwardly black; median lobe clothed with flat scales, chiefly bluish-silvery, though those round the border are black. A stripe of bluish-silvery scales extending across the pleurae from the prothoracic lobes on to the first abdominal segment; a small patch of silvery scales at the base of each coxa. Postnotum with two or three small dark bristles (perhaps not constant). *Abdomen*: dorsum black, each of segments ii.–vii. with the usual oblique lateral purplish-silvery marks; in this species those on segments vi. and vii. unite above to form complete transverse bands; eighth segment black-scaled. Venter clothed with golden scales, the scales on the apical margin of the last three segments long and black. *Male genitalia*: side-pieces small, with a single long bristle on the dorso-lateral surface; basally there is a thick downwardly-projecting lobe bearing a patch of erect scales; claspers long, thin, curved, with some dark-coloured hairs and scales. *Legs* black-scaled, except the under sides of the femora towards the base, which are yellow. Claws of the four anterior legs in the male unequal, simple; in the female equal, toothed. Hind tibiae distinctly shorter than the others. *Wings* clothed with dark brown scales, those in the lateral series lanceolate or ovate-lanceolate. Base of upper fork-cell nearer base of wing than that of the lower. Halteres with yellow stem and dark knob.

Length 4–5 mm.

Sierra Leone: Freetown (*A. W. Bacot*).

A series was bred by Mr. Bacot from pupae found in water collected at the bases of the leaves of the "Cocked Hat" plant (*Dracaena* sp.); specimens were also obtained, though less frequently, from leaf bases of the "Koko Yam" (*Colocasia antiquorum*), and also of the banana and a species of *Sarsaparella*.

Type ♂ and other specimens presented to the British Museum by the West African Yellow Fever Commission.

This species is allied to *E. quinquevittatus*, but differs therefrom markedly in the structure of the genitalia, and also in the following points: the scales of the head have a more pronounced blue tint; the thoracic stripes are less clearly marked, while the double row of orange scales dividing the median black stripe is absent in *E. quinquevittatus*, and in that species the silvery marks on the sixth abdominal segment do not meet above.

It is interesting to note that Mr. Bacot found a definite fauna in the leaf-axils; larvae of *Stegomyia simpsoni*, Theo., and *Uranotaenia ornata*, Theo., were nearly always present with *Eretmopodites dracaenae*, and often also a species of *Ceratopogon* and a small Psychodid (? *Pericoma* sp.). With the exception of *Stegomyia simpsoni* these larvae were found nowhere else.

Wyeomyia grenadensis, sp. n.

♀. Closely related to *W. clasoleuca*, D. and K., from which it differs as follows :—Scales on prothoracic lobes blue or violet below, coppery above ; those on the scutum (mesonotum) black, with scarcely any metallic lustre ; those on the area behind and above the prothoracic lobes almost white. Tibiae, front tarsi, and first three joints of the hind tarsi black-scaled below as well as above ; middle tarsi pale-scaled below, becoming paler apically, scales on the apical joints whitish yellow ; fourth hind tarsal joint with white scales below on the basal four-fifths ; fifth hind tarsal entirely white-scaled below. Terminal abdominal setae dark.

GRENADA (*A. Macdonald*).

Six females received by the Wellcome Bureau of Scientific Research ; type and two other specimens presented to the British Museum.

The slight colour differences between this and *W. clasoleuca* would seem to indicate that the two are only geographical species, but as the males of both are unknown the point must remain undecided at present.

Anopheles domicolus, sp. n.

♀. *Head* with the usual white and black upright forked scales, the former constituting a moderately large patch on the vertex ; very long sinuous white scales projecting forwards from the front. Proboscis black-scaled. Palpi black-scaled, with a narrow white ring embracing the articulation of the first and second joints, and two much broader white rings, one covering the tip of the second joint and the basal third of the third joint, the other covering the apex of the third joint and the whole of the fourth ; these two outer white rings are equal in breadth and distinctly broader than the black ring which separates them ; the terminal palpal joint is barely one-third as long as the penultimate. Antennae with the basal joint yellowish ; second joint with some small white scales ; second and following joints (except the last two) with whitish hairs. *Thorax* : prothoracic lobes with a number of black bristles, prosternum with a single bristle ; scutum with black bristles and very narrow, slightly curved white scales, the latter more dense towards the front margin ; sides of scutum rather broadly dark brown, the median area light grey, without distinct markings. *Abdomen* blackish, the hairs yellowish ; no scales. *Legs* black, the tips of the tibiae and of the first two tarsal joints on all the legs white ; on the hind legs the tips of the third and fourth and the bases of the second, third, fourth and fifth tarsal joints are also white. *Wings* with the scales of the lateral series linear-lanceolate ; markings as follows :—costa with five black spots, the first basal and about as long as the third, second and fourth a little shorter, fifth less than half as long as the fourth ; first three separated by very narrow white spots, the white between the third, fourth and fifth broader. A small black spot in the wing fringe at the tip.

First longitudinal vein marked like the costa, except that the basal black spot is absent, and the second (the one below the third costal) is narrowly interrupted with white near the base. Second vein white about the place of origin of the third vein, at the base of the fork and at the tip of the upper branch of the fork, otherwise black.

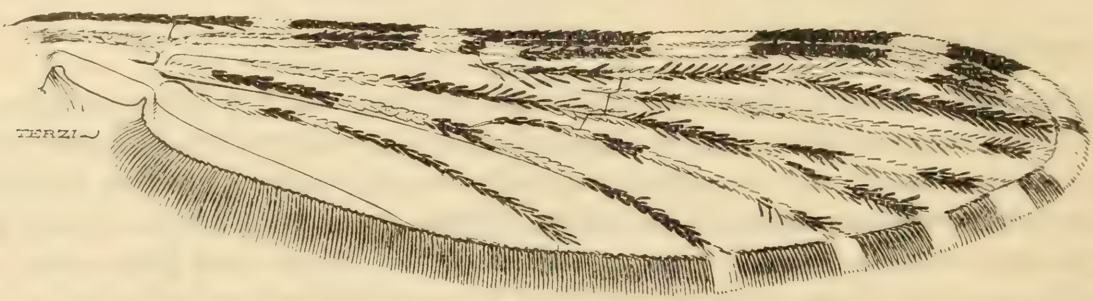


Fig. 5. Wing of *Anopheles domicolus*, Edw., sp. n.

Third vein white, with small black spots close to the base and tip. Fourth vein black, white towards the base, about the cross-vein, at the base of the fork and at the tip of each branch. Fifth vein black with a small white spot at the extreme base, a longer one before the fork, very small ones at the cross-vein and at the tip of the upper branch, longer ones beyond the middle of the upper branch and near the base of the lower branch. Sixth vein black with two rather small white spots, one at and the other near the base. Pale fringe spots opposite the terminations of all the veins except the sixth. Upper fork-cell with its base nearer the base of the wing than that of the lower.

Length of body, 3·5 mm.; of wing, 3·3 mm.

Northern Nigeria: Zungeru, Oct.–Nov. 1915, six females taken in bungalow (*Dr. W. B. Johnson*); presented to the British Museum by the collector.

This species belongs to the *A. marshalli* group, the members of which are closely allied and difficult to separate, and in some cases of doubtful specific rank. The new form differs from *A. marshalli*, which it resembles most closely, in having the base of the costa entirely dark, no white interruption in the middle of the third black spot on the first longitudinal vein; a longer black spot near the base of the fifth vein; white rings at the bases of the last four hind tarsal joints; and, most important, shorter and slightly broader wing-scales. In none of the six specimens does there appear to be any variation in regard to any of these points, and although *A. marshalli* is somewhat variable, I have not seen a specimen which could be confused with the present form. It therefore seems justifiable to regard these Nigerian specimens as belonging to a species distinct from *A. marshalli*, though probably representing it in this region.

SOME INJURIOUS INDIAN WEEVILS (CURCULIONIDAE)—II.

By Guy A. K. Marshall, Hon. D.Sc. (Oxon.).

Among some weevils forwarded for identification by Mr. T. Bainbrigge Fletcher, Imperial Entomologist, Pusa, Bengal, certain species were indicated as causing damage of economic importance; of these the following six species proved to be undescribed.

Emperorrhinus, gen. nov.*

Rostrum stout, longer than the head and continuous with it; the mandibles very unequal, the left being much the larger and projecting (when closed) considerably beyond the genae; in conformity with this, the left gena is also more developed and projects further beyond the scrobe than does the right one, the rounded apical excision of the rostrum being therefore asymmetrical; the scrobes dorsal and apical, short and curving abruptly inwards, so that the space between them is scarcely half the width of the forehead; the process covering the condyle of the antenna convex, testaceous and shiny, superficially appearing as though it might be the condyle itself; mentum small, subcircular and bearing a transverse row of four bristles. *Antennae* long and slender, the scape curved and reaching the middle of the prothorax, the two basal joints of the funicle elongate, the remainder longer than broad. *Prothorax* truncate at the base, the anterior margin laterally sloping backwards from above downwards; the anterior coxae quite close to the front of the prosternum. *Elytra* much broader than the prothorax and with prominent shoulders. *Abdomen* with the intercoxal process ogival, segment 2 slightly longer than 3 and 4 and separated from 1 by a deeply sinuate incision. *Legs* slender, all the femora with a single small tooth, the corbels of the posterior tibiae open, the tarsal claws free.

Genotype, *Emperorrhinus pyricola,* sp. n.

This genus, which belongs to the group Phyllobiini, is nearly related to *Myllocerus,* with which it agrees in most characters, but it should readily be distinguished by the remarkable asymmetry of the rostrum, a character which I have never previously observed in any adelognathous Curculionid. Other points which distinguish the genus from *Myllocerus* are, the projection of the closed mandibles well beyond the apices of the genae and the proximity of the front coxae to the anterior margin of the prosternum.

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* *ἔμπηρος,* deformed; *ῥίς,* nose.

Emperorrhinus defoliator, sp. nov. (fig. 1).

Black, densely clothed with mingled black and bright metallic green scaling ; head and rostrum green ; prothorax green, with a broad central black stripe ; elytra variable, but with the green and black scaling fairly equally distributed in alternating small subquadrate patches on the dorsal intervals ; there is often a somewhat large black patch near the base on intervals 3 to 6, and occasionally the black scales greatly predominate.

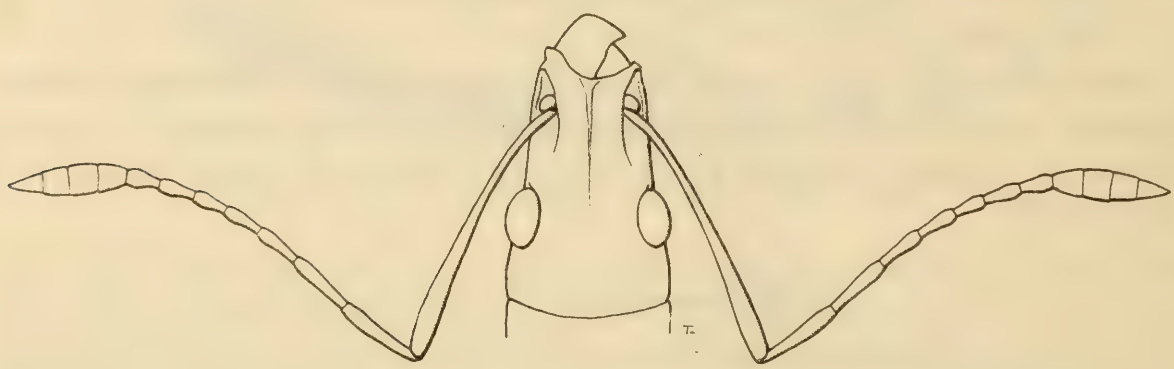

Fig. 1. Head of *Emperorrhinus defoliator*, Mshl., sp. n.

Head finely striolate longitudinally, the fore head quite twice as broad as the space between the scrobes, the eyes moderately convex. *Rostrum* with the left side (excluding the mandible) somewhat shorter than the basal width, distinctly narrowed from the base to apex, the sides being almost straight ; the interscrobal area almost plane, finely striolate beneath the scaling, and with a fine central carina in the anterior part. *Antennae* reddish brown ; the funicle with the two basal joints subequal, or the first very slightly longer, the remaining five subequal and much longer than broad. *Prothorax* transverse, truncate at base and apex, which are of equal width, the sides rounded only in the middle, markedly constricted in front and behind ; the dorsum rather uneven, without any central furrow or carina, the somewhat rugose punctures normally hidden by the scaling, the setae suberect and all directed forwards. *Elytra* much broader than the prothorax at the shoulders, which are rounded rectangular, parallel-sided in the male and slightly dilated behind the middle in the female, the apices jointly rounded, and the dorsal outline only slightly convex ; the shallow striae not hidden by the scaling and containing shallow punctures, the intervals almost plane, shining and impunctate ; the scales small, convex and subcircular, the green ones for the most part contiguous, the black more sparse, so that the shining surface is partly visible ; the setae slender, long, dark and erect. *Legs* red-brown, the femora darker, with recumbent pale setae and scattered green scales.

Length, $2\frac{1}{2}$–$3\frac{1}{2}$ mm. ; width, $1\frac{1}{4}$–$1\frac{1}{2}$ mm.

PUNJAB : Chawai, Kulu, Kangra district (*type*). SIKKIM : Kurseong, 6,000 ft. (*E. A. D'Abreu*) ; Darjiling (*Harmand*). ASSAM : Khasi Hills (*teste* H. E. Andrewes).

This species superficially resembles such small *Myllocerus* as *M. dorsatus*, F., and *M. pretiosus*, Fst., but may be readily distinguished by the abnormal structure of the rostrum. I have examined 36 specimens.

Mr. C. F. C. Beeson, Imperial Forest Zoologist, Dehra Dun, from whom specimens have also been received, states that this species defoliates various kinds of fruit trees, such as, pears, peaches, cherries, etc.

Mr. Fletcher states that the correspondent from whom he received his specimens informed him that the weevils first appeared on an alder tree (*Alnus nitida*) in a field adjoining his orchard. After completely defoliating the alder, they attacked his peach trees, and then turned their attention to the apricots and pears, apples being the last trees to be touched. The whole orchard was entirely defoliated.

Coniatus indicus, sp. nov.

Colour black, densely clothed with bright metallic green scaling, the vertex of the head and almost the entire disk of the prothorax with pink scales, the pink area with more or less blackish scaling laterally in the basal half ; the elytra with a common broad anchor-shaped black patch near the base ; its arms extending indefinitely to beyond the third stria and the shaft running along the first interval to the base ; behind the middle another common **V**-shaped black marking, the arms of which extend to the 6th or 7th stria and are crossed obliquely by a short black stripe lying on intervals 4 and 5 ; the space between these two black markings and a large patch on the declivity behind them covered with pink scales.

Head with the forehead much broader than the diameter of the eye and broader than the rostrum in its widest part. *Rostrum* gradually dilated from base to apex, scarcely as long as the prothorax and only slightly curved ; colour testaceous, the basal half rather coarsely punctate and covered with scaling, the apical half more or less bare and shining ; the scrobes continued in front of the antennae in the form of a furrow, and above this a punctate longitudinal impression. *Antennae* inserted well beyond the middle of the rostrum, testaceous, with sparse green scales ; the scape not nearly reaching the eye, the funicle with joint 1 much broader than the rest and nearly as long as the next three together, joint 2 longer than 3, the remainder subequal and scarcely as long as broad. *Prothorax* as long as broad, subparallel-sided from the base to beyond the middle, thence narrowing to the apex, the basal margin somewhat oblique on each side so that there is a slight angle in the middle ; the upper surface uniformly set with contiguous shallow punctures which are quite hidden by the scaling. *Elytra* relatively broad, parallel-sided, the humeral prominence well developed, the apical area not produced but broadly rounded, the apical declivity steep and the posterior calli feeble. *Legs* black, with the tarsi and the base and apex of the tibae red-brown, the whole densely clothed with green scaling, the tarsal claws black with the tips red-brown, the tarsi unusually long and slender, especially the fourth joint.

Length, $2\frac{1}{2}$–$3\frac{1}{4}$ mm. ; width, $1\frac{1}{4}$–$1\frac{5}{8}$ mm.

BENGAL : Pusa.

This pretty little weevil is interesting as being the first species of the genus recorded from outside the Palaearctic Region. It is most nearly allied to *C. splendidulus*, F., from Siberia, with which it agrees in having the mesosternal process dilated at the apex ; but in that species the apical portion of the elytra is distinctly more produced, the posterior declivity slopes much more gradually and the posterior calli are more prominent, while the 4th joint of all the tarsi is distinctly less elongate. The following

colour distinctions also appear to be reliable ; in *C. splendidulus* the anterior black marking on the elytra is merely a longitudinal patch without anchor-like arms, the succeeding pink area extends right up to the shoulder (whereas it always ceases long before the shoulder in *C. indicus*), and the tibiae are entirely testaceous. The colouring of *C. indicus* appears to be relatively constant in a long series of specimens.

This weevil is recorded as attacking *Tamarix indica*, and most of the palaearctic species appear to be specially attached to plants of this genus.

Ceuthorrhynchus portulacae, sp. nov. (fig. 2).

Colour black or dark brown, with the antennae, tarsi, tibiae and apex of the rostrum paler ; fairly densely clothed with elongate, truncate, slightly elevated, greyish and brownish scales, which are mingled irregularly and through which the shiny integument is easily visible ; the pronotum has in the basal half a central stripe composed of much broader ovate whitish scales ; this stripe is continued on to the first interval of the elytra, extending for about one-third of its length, but here the scales are more dense and often of a yellowish or brownish tinge.

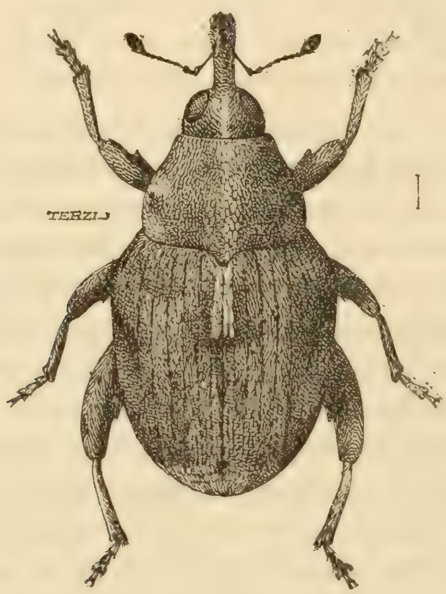

Fig. 2. *Ceuthorrhynchus portulacae*, Mshl., sp. n.

Head with coarse confluent punctation, the forehead broad and flat ; the scales narrower than those on the pronotum, elevated along the margin of the eyes but recumbent elsewhere, those on the forehead directed backwards, those on the vertex directed forwards. *Rostrum* comparatively stout and unusually short, scarcely as long as the prothorax in the ♀, shorter in the ♂, gently curved and gradually dilated from base to apex, being there about as broad as the apical portion of the front femur ; the upper surface coarsely punctate and with sparse narrow scales as far as the antennae, beyond that smooth and almost impunctate. *Antennae* testaceous, inserted well beyond the middle of the rostrum, the scape terminating in a sharp point ; the funicle with joint 1 longer and much broader than the others, 2–4 much longer than broad and diminishing progressively in length, 5–7 subequal and about as long as broad. *Prothorax* transverse, broadest near the base and thence strongly narrowed to the apex, the sides being almost straight, the front margin forming an elevated

lamina dorsally which is broadly sinuate in the middle, the base deeply bisinuate; the upper surface moderately convex and with coarse reticulate punctation throughout, a small tubercle on each side a little behind the middle, and a basal impression in front of the scutellum. *Elytra* scarcely as long as their greatest width, broadest at the shoulders, which are rounded, and gradually narrowed behind, the sides being almost straight; upper surface with a flattened triangular area in the basal half, the posterior declivity sloping gradually and without any prominent tubercles, a deep impression round the scutellum, the striae rather shallow and not very conspicuous through the scaling, owing to each containing a row of recumbent setae, the intervals broad, very rugosely sculptured in the flattened area and rather less so elsewhere. *Legs* fairly densely clothed with narrow elongate whitish scales.

Length, $2\frac{1}{2}$ mm.; width, $1\frac{1}{2}$ mm.

BENGAL: Pusa.

Recorded as injuring purslane (*Portulaca oleracea*), which is cultivated as a vegetable. The larvae mine the leaves of the plant.

Only two species of *Ceuthorrhynchus* have been previously described from India, *C. asperulus*, Fst. (D. E. Z., 1898, p. 323) and *C. sexnotatus*, Schultze (D. E. Z., 1899, p. 190). The former may be distinguished by the following characters, *inter alia*: the sides of the prothorax are parallel in the basal half and the apical margin is not sinuate dorsally, the entire upper surface bears only setae without any scales, and the intervals of the elytra are set with small acute tubercles. *C. sexnotatus* has a much longer and more slender rostrum, which is tricarinate in the basal portion; the terminal joints of the funicle are double as long as broad, and the apical margin of the prothorax is not elevated; it is a much larger insect ($4\frac{1}{2}$–5 mm.) and differs in colouring. A much nearer ally is the European *C. cognatus*, Schultze, which is very similar in general shape and sculpture, but the rostrum is much longer and more slender, the anterior edge of the prothorax is not so elevated nor sinuated, the elytra are much less coarsely sculptured, the legs are much stouter and the femoral tooth is larger.

Baris portulacae, sp. nov. (fig. 3).

General colour black, the head, rostrum and legs red-brown; prothorax rather thinly covered with long truncate yellow-brown scales, all lying transversely, and leaving bare a narrow median line, a basal patch on each side of it, and the anterior angles; elytra with a transverse basal patch of similar scales extending on each side to the third stria and continued backwards as a narrow sutural stripe to well beyond the middle, where it unites with a transverse band of white scales, which extends on each side as far as the fourth stria; a small humeral spot of white scales, and a few isolated white scales on intervals 5, 7 and 9 and near the apex; venter with very minute sparse white scales; sternum with much larger and closer scales, which are densest on the side-pieces.

Head bare, finely shagreened, with scattered shallow punctures. *Rostrum* strongly bent near the base and gently curved beyond, slightly dilated from base to apex, coarsely punctate throughout, each puncture containing a minute white seta, and with two fine longitudinal carinae on each side; a tuft of a

few yellowish scales at the base just above the eye. *Antennae* red-brown, with the scape paler ; funicle gradually widening to apex, joints 2 to 7 transverse, 2 scarcely longer than 3. *Prothorax* about as long as broad, almost parallel-sided from the base to the middle, thence roundly narrowed and shallowly constricted near the apex, coarsely punctate throughout, with a smooth narrow central line extending from the apex nearly to the base. *Scutellum* small, subcircular. *Elytra* a little broader at the shoulders than the prothorax, deeply striate, the intervals plane and shiny, bearing one or two irregular rows of faint punctures, each containing a small recumbent dark seta. *Legs* clothed with long white scales, the femora sub-linear and without a tooth, the second joint of the tarsi scarcely broader than the first, the tarsal claws free.

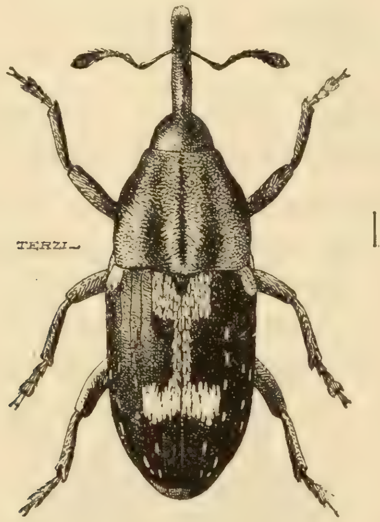

Fig. 3. *Baris portulacae*, Mshl., sp. n.

Length, 2·5–3·5 mm. ; width, 1–1·75 mm.

Bengal : Pusa.

Boring in the stems of purslane (*Portulaca oleracea*).

I know of no Indian species which much resembles this insect, but it is very closely allied to *B. multivaga*, Champion, from the Seychelles. The latter is a rather larger insect in which the punctures on the prothorax are more widely separated, while those on the elytra are much coarser than in *B. portulacae*.

Baris lorata, Mshl. (Ent. Mo. Mag., 1911, p. 207) attacks the same plant in the Anglo-Egyptian Sudan.

Athesapeuta oryzae, sp. nov. (fig. 4).

Ground-colour rather shiny black, ornamented with patches of elongate yellowish-white scales ; the whole lower surface fairly densely scaled, the scales being somewhat closer on the meta-episternum ; head and rostrum bare ; prothorax with a broad lateral stripe, which is continuous with the scaling of the lower surface, but interrupted about the middle by a small bare kidney-shaped spot ; elytra with a large basal patch consisting of lines of scales on intervals 3–8, those on 5 and 6 the longest, those on 4, 3, 7 and 8 diminishing in the order given, the whole patch covering about one-third

of the elytra and leaving the shoulder bare ; close behind it another large irregular patch, the lines of which on intervals 2, 3, 4, 8 and 9 are short, 5, 6 and 7 being longer, that on 5 usually the longest ; and finally, a V-shaped apical patch extending from interval 3 to 8.

Head regularly convex, very finely shagreened, fairly closely and regularly set with deep punctures. *Rostrum* separated from the head by a distinct impression, a little longer than the prothorax, strongly curved, coarsely punctate, especially at the sides, and with an impunctate central line. *Antennae* black, with whorls of stout yellowish white setae ; joint 1 twice as long as 2, 2 as long as 3 and 4 together, 3–7 transverse. *Prothorax* slightly broader than long, broadest at the base, the sides gently rounded,

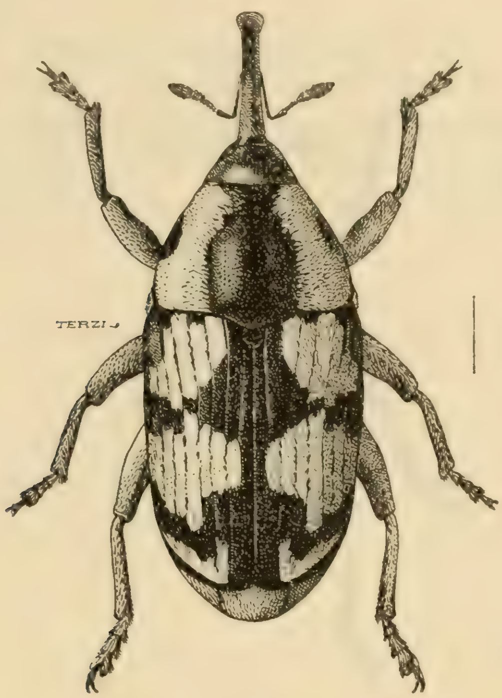

Fig. 4. *Athesapeuta oryzae,* Mshl., sp. n.

with a broad but shallow apical constriction, the upper surface coarsely and closely punctate, with an abbreviated impunctate line in the middle only. *Scutellum* strongly transverse, coarsely punctate and with narrow scales ; the posterior margin truncate or slightly angulate. *Elytra* oblong, broader than the prothorax at the shoulders, the apices separately rounded, deeply striate, the intervals almost plane, with irregular coarse punctures. *Legs* black, fairly densely clothed with yellowish white scales.

Length, 5·5–6 mm. ; width, 2·5–2·75 mm.

MADRAS : Coimbatore (*type*) ; Pithapuram, Godaveri.

Nearly allied to *Athesapeuta famula,* F., but in that species the scaling of the upperside is of an orange-red colour and more extensive, leaving only a median row of three bare patches, a circular one on the thorax, a triangular anterior and kidney-shaped posterior one on the elytra ; the shoulders of the elytra are also less prominent, and the punctures on the intervals are much finer. *A. oryzae* is stated to be a serious pest of rice.

Acythopeus citrulli, sp. nov. (fig. 5).

Colour uniform dull black, entirely devoid of scaling both above and below. *Head* very finely shagreened and with small scattered shallow punctures. *Rostrum* about as long as the prothorax in the ♀, strongly curved, rather slender, and slightly dilated above the insertion of the antennae and at the apex, the upper surface closely and strongly punctate to beyond the middle, the punctures on the apical portion rather smaller and more distant, the scrobe continued as a shallow furrow from the antenna to near the apex; the rostrum of the ♂ shorter, more evenly punctate throughout, and less dilated at the middle and apex. *Antennae* with joint 1 of the funicle equal to 2–4 inclusive, joint 2 about as long as broad, the remainder transverse and slightly widening outwardly, the basal joint of the club a little longer than the rest together. *Prothorax* about as long as broad, the sides subparallel near the base,

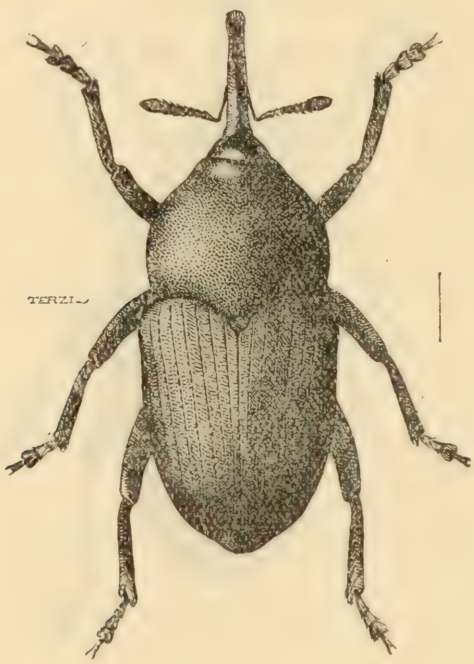

Fig. 5. *Acythopeus citrulli*, Mshl., sp. n.

thence rounded and strongly narrowed in front so that the apex is one-third the width of the base, with a distinct apical constriction, the base deeply bisinuate, the median lobe broadly rounded, the dorsum convex, densely and evenly set with large shallow punctures, the intervals between which form a regular raised net-work without any trace of a central line. Prosternum with a shallow longitudinal impression in front of the coxae containing two deep foveae placed transversely. *Scutellum* trapezoidal, the posterior margin being nearly twice as broad as the anterior. *Elytra* evidently broader at the shoulders than the prothorax and thence narrowed to the apex; the striae fairly deep and shiny, with the sides sharply cut and containing deep separated punctures throughout, the striae being rather broader and deeper just near the apex, where 9 and 10 unite to form a deep furrow; the intervals much broader than the striae, plane and finely shagreened, each with an irregular row of very shallow punctures (more or less duplicated near the base) each containing a short recumbent

dark seta ; the posterior callus feeble and an oblique costa behind it, which is virtually a continuation of interval 9. *Sternum* with close punctures throughout similar to those on the pronotum. *Venter* shagreened at the sides and there with punctures like those on the sternum but more shallow and separated, shiny in the middle and with much smaller and more scattered punctures, segments iii. and iv. being impunctate in the basal half. *Legs* dull, with coarse subconfluent punctation and short recumbent pale setae ; the posterior pairs of femora strongly furrowed beneath, the tibiae subsulcate externally.

Length, $4\frac{1}{2}$–$5\frac{1}{2}$ mm. ; width, $2\frac{1}{4}$–$2\frac{1}{2}$ mm.

MADRAS : Coimbatore ; Hadagalli (*type*) and Hagari, Bellary District ; Koilpatti, Tinnevelli District.

A pest of water melons.

The previously described species of *Acythopeus* are all from the Malay Archipelago, and the present species may be distinguished from them by the impressions on the prosternum. In general shape and structure it is very like another South Indian Barid, *Apotomorrhinus cribratus*, Boh., which is however a dark brown insect, with a small tooth on the femora and with the first joint of the club much longer than all the rest together.

REPORT ON SOME COCCIDAE FROM ZANZIBAR, COLLECTED BY DR. W. M. ADERS.

By E. Ernest Green, F.E.S., F.Z.S.

The collection contains no novelties or species of special interest. The enumeration of them will, however, contribute to a knowledge of the local fauna of the country, of the distribution of the several species, and of the plants that they affect.

Icerya seychellarum, Westw.

"On *Citrus limonii.*" (I.B.E., No. 55.)

Asterolecanium bambusae, Bdv.

"On stems of large bamboo." (I.B.E., No. 49.)

Pseudococcus citri, Risso.

"On immature cotton bolls, under sepals. Zanzibar Town." (I.B.E., No. 58.)

Pseudococcus crotonis, Green.

Food-plant not mentioned. (I.B.E., No. 66.)

These examples are not quite typical, but the differences are not sufficient to justify their description as a new species, without more ample material for study.

Pseudococcus perniciosus, Newst.

"On Shu-Shu"—a Cucurbitaceous plant. (I.B.E., No. 51.)

Pseudococcus virgatus, Ckll.

"On cotton (*Gossypium*)," and "on *Clitoria*," both at Zanzibar Town. (I.B.E., No. 54.)

Lecanium hesperidum, L.

"On indigenous fern: Chaké-Chaké, Pemba Is." (I.B.E., No. 64.) Every single individual has been parasitized.

Lecanium viride, Green.

"On coffee leaves and young terminal shoots: Mbweni, Zanzibar." (I.B.E., No. 61.)

Pulvinaria antigoni, Green.

"On stem of chilies: Zanzibar Town," and "on leaf of *Luffa acutangula*: Indian Prison garden." (I.B.E., Nos. 70 and 71.)

Both of these gatherings were very heavily parasitized, a condition which I have observed to be the case with material of the same species from Mauritius.

P. antigoni is well characterized by the rather loose series of long, curved, acutely pointed marginal hairs. My original description of the species does not sufficiently emphasize this character. Amongst the pointed hairs may be found an occasional one that is slightly frayed at the extremity. All the marginal hairs are much longer and stronger than in *P. psidii,* to which it was compared.

Ceroplastes floridensis, Comst.

A single example "on avocado pear: Zanzibar Town." (I.B.E., No. 62.)

Ceronema ? africana, Macfie.

"On Leguminous climber." (I.B.E., No. 56.)

Not in good condition for exact determination. The fragments show dermal pores and marginal spines similar to those of the type. The limbs and antennae are missing. The male puparia have a large turret-shaped pad of wax on the median dorsal area which is not noted by Macfie.

Aspidiotus cyanophylli, Sign.

"On husk of coconut: Koani, Zanzibar." (I.B.E., No. 68.)

Aspidiotus destructor, Sign.

"On husk of coconut: Koani, Zanzibar." (I.B.E., No. 68, part.)

Aspidiotus dictyospermi, Morgan.

"On stem of seedling mango: Marahubi, Zanzibar." (I.B.E., No. 73.)

Aspidiotus ficus, Ashm.

"On rose stalks." (I.B.E., No. 52.)

Aspidiotus lataniae, Sign.

"On husk of coconut: Koani, Zanzibar." (I.B.E., No. 68, part.)

Aspidiotus trilobitiformis, Green.

"On pomelo (*Citrus decumana*) leaves: Chaké-Chaké, Pemba Island," (I.B.E., No. 63). Described as a "very severe infestation." Also "on Ficus elastica: Prison Island," (I.B.E., No. 65); and "on young Citrus trees: Marahubi, Zanzibar," (I.B.E., No. 72.)

Diaspis pentagona, Targ.

"On *Hibiscus sabdarifa* and papaw fruits: Mazazini, Zanzibar." (I.B.E., No. 76.)

Hemichionaspis minor, Mask.

"On husk of coconut: Koani." (I.B.E., No. 68, part.)

Hemichionaspis sp., near *rhododendri*, Green.

"On sisal hemp: Prison Island, Zanzibar." (I.B.E., No. 59.) The characters of the pygidium come nearest to *rhododendri*, but there are differences which, if constant, would justify a new name. Further material would be required for exact determination.

Ischnaspis longirostris, Sign.

"On coffee: Mbweni, Zanzibar." (I.B.E., No. 60.)

Lepidosaphes citricola, Packard.

"On orange rind: Zanzibar Town," (I.B.E., No. 69); and "On young orange tree." (I.B.E., No. 74.)

ON A NEW COCCID PEST OF CACAO FROM TRINIDAD.

By E. Ernest Green, F.E.S., F.Z.S.

Philephedra theobromae, nov.

Adult female broadly oval, convex above. Body soft (not rigidly chitinous as in most Lecaniinae). Colour of examples preserved in alcohol, whitish to brownish ochreous; with two median longitudinal series of small depressed dark spots and transverse series of similar spots radiating from the median series to the margin. Photographs of the insect in alcohol (fig. 1) show the marginal area to be rather closely coated with white pulverulent secretion, with traces of a lamellate marginal fringe of waxy matter; in some examples there are irregular flecks of secretion on the dorsum.

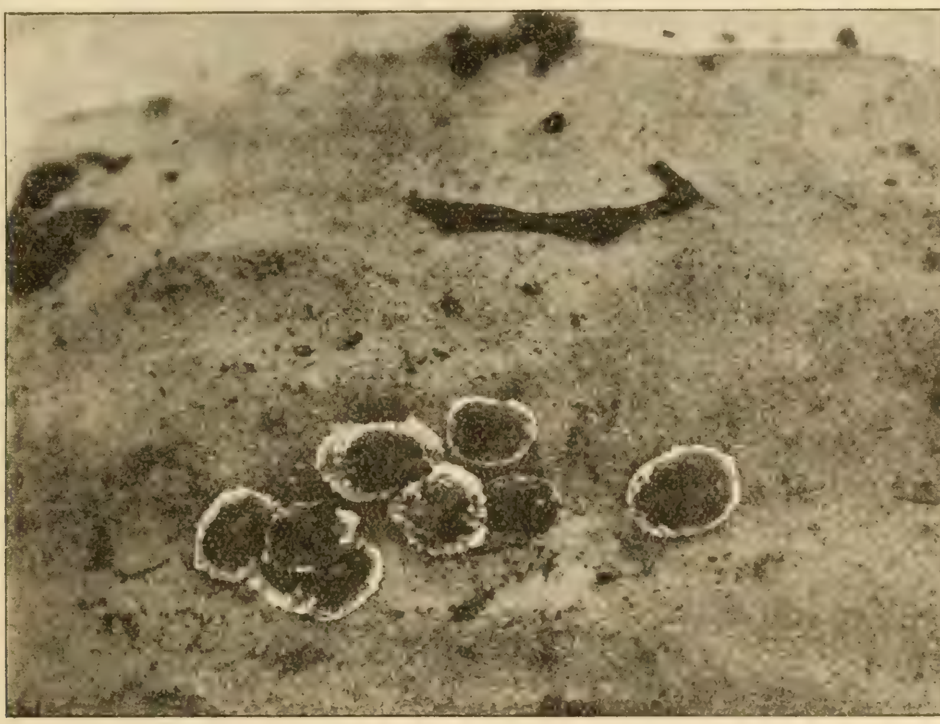

Fig. 1. *Philephedra theobromae*, Green, sp. n., on a cacao pod; photographed in alcohol. × 2·7.

In the photograph the body of the insect appears to be dark-coloured. Limbs and antennae rather small in proportion to the size of the insect (fig. 2, *a*). Antenna normally 8-jointed (fig. 2, *b*); occasionally 7-jointed (fig. 2, *c*); in a single example the antenna on one side shows 9 joints, apparently through a duplication of the 5th. The 3rd joint is considerably the longest; the 4th, 5th and 8th are approximately equal; average antennal formula—3, 2, (4, 5, 8), 6, 7; the first joint being of irregular form is invariably distorted by compression and is not included in the formula. Each joint, except the 4th, bears one or more hairs at its distal end, that on the 2nd joint being exceptionally long. Legs small but moderately robust. Tarsus more

than half the length of the tibia; strongly bowed, especially on the anterior limbs (fig. 3, *a*). Tibia slightly bowed in the opposite direction to the tarsus. Claw stout and strongly falcate; ungual digitules moderately dilated, tarsal digitules long and slender. Spiracles proportionately large, with conspicuous trumpet-shaped orifices.

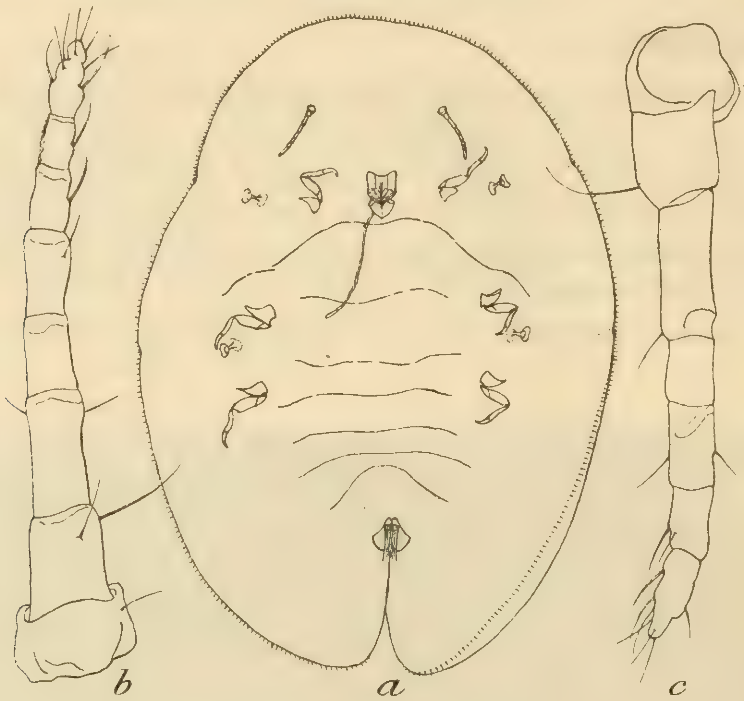

Fig. 2. *Philephedra theobromae*, Green, sp. n.; *a*, adult ♀ under compression, × 20; *b*, antenna, 8-jointed form, × 187; *c*, antenna, 7-jointed form, × 187.

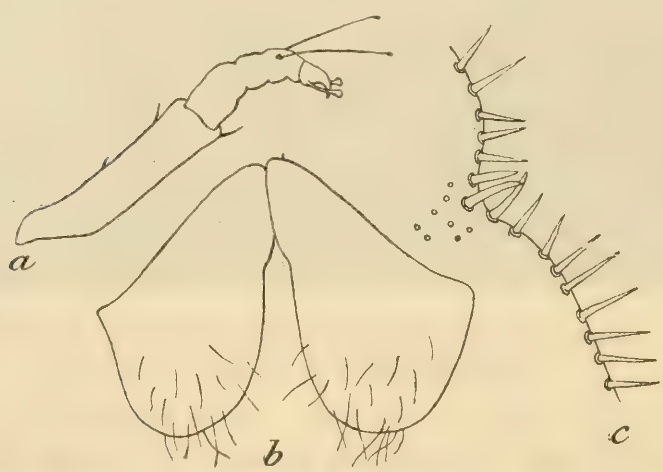

Fig. 3. *Philephedra theobromae*, Green, sp. n.; *a*, foot of anterior limb, × 187; *b*, anal operculum, × 187; *c*, marginal and stigmatic spines of early adult ♀, × 187.

Valves of anal operculum with bluntly rounded apices; the base much longer than the outer margin; the apical area with numerous hair-like setae (fig. 3, *b*). Anal ring with eight long and stout setae, and with a pair of rather shorter setae on the outer lip of the invaginated anal pit. Margin of body with a close fringe of sharply pointed

slender spines, of which there are from 25 to 35 between the anterior and posterior stigmatic areas. Stigmatic clefts shallow, scarcely perceptible in old adults, but more clearly defined in the early adult insect. Stigmatic spines 3, only slightly differentiated from those of the marginal fringe (fig. 3, *c*). Length of mature female (under compression) 3·50 to 4·50 mm. Breadth 2·50 to 3·0 mm.

Other stages not observed.

On pods of *Theobroma cacao*; Trinidad, W.I. Collected by Mr. F. W. Urich (Entomologist to the Board of Agriculture, Trinidad) who reports that the insects were " enclosed in a carton tent, and were attended by the ant, *Azteca chartifex*."

Cockerell erected the genus *Philephedra* to contain a species from New Mexico that was originally described as *Pulvinaria ephedrae*. He considers the genus to be more nearly related to *Lichtensia* than to *Pulvinaria*, but he has apparently nowhere precisely defined its characters. Those given in his " Table for the Determination of the Genera of Coccidae " (Can. Entom., Nov. 1899, p. 331), viz :—" Body of female soft, not chitinous, pink in front, greenish on dorsum, with some black specks ; back with patches of white " can scarcely be regarded as of more than specific value.

I have had no opportunity of examining specimens of *Philephedra ephedrae*; but, relying upon Cockerell's description (Ann. Mag. Nat. Hist., (7) ii, July 1898, p. 24), I feel confident that the Trinidad insect is closely allied to that species. It may indeed eventually prove to be identical. The differences are principally in the antennal formula, and in the absence of longitudinal bands of white secretion on the dorsum. I have no record of the colour of the living insect of *Ph. theobromae*.

CHALCIDOIDEA BRED FROM GLOSSINA MORSITANS IN NYASALAND.

By James Waterston, B.D., B.Sc.,

Imperial Bureau of Entomology, London.

Since my previous report on the Chalcidoid parasites of *Glossina* appeared (Bull. Ent. Res., vi, pt. 1, p. 69, 1915) a second important collection has been received by the Imperial Bureau of Entomology from Dr. W. A. Lamborn, their Entomologist in Nyasaland. In this materal five species are represented, of which three here described are believed to be new. The status of the remaining two, *Stomatoceras micans*, Wtrst., and *Syntomosphyrum glossinae*, Wtrst., may now be regarded as established, in the former case from its recurrence on the same host in two widely separated localities, in the latter from Dr. Lamborn's valuable notes. Six species of Chalcidoids have now been bred from puparia of *Glossina* spp., and all from *G. morsitans*.

Family CHALCIDIDAE.

Genus Haltichella, Spin.

Haltichella, Spinola, Ann. Mus. Hist. Nat., Paris, xvii, p. 148 (1811).

Genotype, *H.* (*Chalcis*) *pusilla*, Fabricius, Mant. Ins., i, p. 272, ♂ ♀ (1787).

This genus, as I understand it, includes forms with the post-marginal equalling or exceeding the marginal; the wings sometimes tinted, but generally without definite bands or large spots; the lower edge of the hind femur undulated, denticulate up to three-fourths from the apex (or more shortly), but without a major tooth or prominent lobe. Scutellum bidentate; propodeon unarmed; *i.e.*, the single angle behind the spiracle upturned and inconspicuous.

The length of the post-marginal is a character of great importance for arranging the Haltichellines, but one which it is occasionally hard to estimate owing to the infuscation of the costa, which may resemble a continuation of the nervure. In such cases if the wing is looked at from behind edgeways, and highly magnified, one can generally see a distinct difference in the thickness of the costa, indicating the demarcation of the post-marginal. But it is best to examine carefully a wing mounted in balsam. With the two new species which are here assigned to *Haltichella* and *Stomatoceras* (*Centrochalcis*) respectively, Dr. Lamborn has enclosed another very distinct Haltichelline, not, however, bred from *Glossina*. This *Hockeria* is described in a paper (p. 419) immediately following the present one. To facilitate comparison, however, the femoral edge and neuration of the *Hockeria* have been illustrated here (figs. 1 and 2).

Haltichella edax, sp. nov.

♂. Head, antennae and thorax black; tegulae dark brownish fuscous. Abdomen: first visible segment broadly black basally, the dark area extending medianly through the second segment and into the third; at the sides posteriorly segment i. is transparent dark brown, the same colour flanking the black area on segments ii. and iii. also. Apical third of abdomen and sides entirely clear dark brown. Legs: fore coxae black; mid coxae black, but lighter on the apical one-fourth; hind coxae dark clear red, black only on the upper basal half; legs otherwise reddish, paler on

anterior tibiae and tarsi, but somewhat dusky on the hind tibiae ; denticles of the femur black ; claws dark brown, only the tips blackish. Wings unbanded and immaculate ; hyaline near the base, but a little tinted elsewhere so as to appear dusky, especially below the marginal and on apical half ; veins still more infuscated. Pubescence silvery white, darker on dorsum of abdomen posteriorly.

Head exceeding the thorax, but less than the extended tegulae in width ; deeply excavated behind the scapes, the depression flanked by raised ridges along the orbits. Eyes large, separated on the vertex by one and one-third diameters. *Antennae* : length, 2·2 mm. Scape broader basally and contracted subapically, where the proportion of length to breadth is as 9 : 1 ; pedicel short, about one-fourteenth of the scape and two and a half times as long as the minute ring joint. First funicular joint longest, a little swollen dorsally ; funicle cylindrical, tapered off slightly on the club ; proportions, 20 : 17 : 16 : 15 : 14 : 13 : 13 ; and club, 10 : 14—there being only one clear suture. Average breadth of funicle, 15, so that the last four joints are transverse.

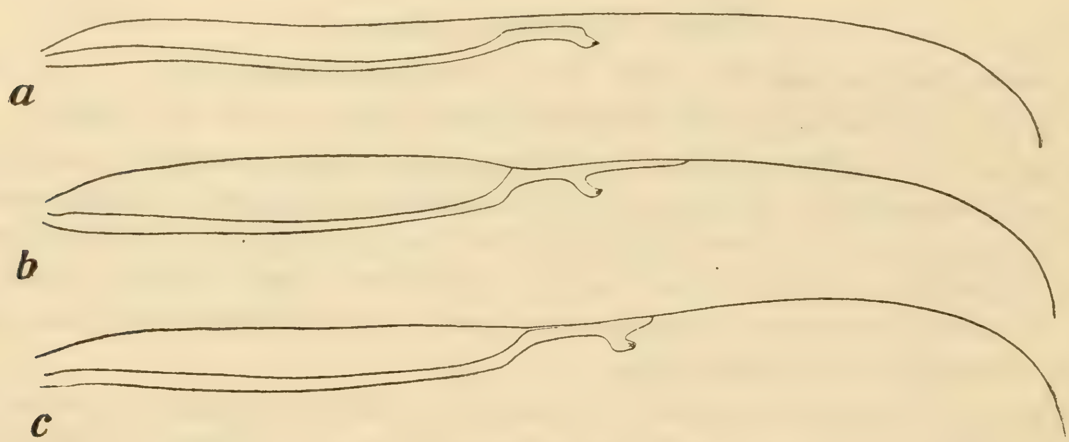

Fig. 1. Neuration of :—*a, Hockeria munda*, sp. n. ; *b, Haltichella edax*, sp. n. ; *c, Stomatoceras exaratum*, sp. n.

Thorax with thimble-like punctures all over, rather shallow and not closely set ; the integument between roughened, finely reticulate. Prothorax descending abruptly behind the occiput, narrow medianly, expanded at the sides anteriorly, with a strong ridge which is much raised laterally, and indistinct only narrowly in the middle ; mesonotum in the form of a long isosceles triangle, narrowing evenly backwards from the suture with the prothorax to the apex of the scutellum, which lies just over the insertion of the petiole. Scutellum bidentate, the teeth approximated and so connected medianly that the concavity between is somewhat shallow.

Propodeon triangular. The spiracle narrow and long, with one low pro ection behind, which being upturned is very inconspicuous from above. The central cell is broad, with an indistinct transverse ridge and two punctures before the petiole ; on either side are three large cells, bounded outside by the inner ridge, before the notopleural edge. The cell between the ridge and the edge is oblong (with 4–5 indistinct transverse ridges) extending nearly to the spiracle and entirely covered with refringent bristles. There is one large cell in the angle before the spiracle and another behind it. Immediately behind the metanotum there is a row of indistinct punctures ; the metapleurae are swollen and covered with short bristles.

Fore wings over two and a half times as long as broad ; length, 2·9 mm. ; breadth, 1·1 mm. Submarginal : marginal : radius : post-marginal, as 26 : 5 : 1 : 6. Pubescence of similar elements, no scales. Submarginal with 38 bristles, with short bristles 3–4 deep along its whole length below ; submarginal cell closely set with bristles along its outer costal half ; wing otherwise evenly ciliated, except on the basal <-shaped bare area and the hairless longitudinal line. *Hind wings* : length, 2·15 mm. ; breadth, 0·65 mm. Basally the vein runs along the costa for half the length of the cell ; it bears 80–90 bristles which are coarser distally ; only six stiff bristles on the frenulum.

Hind legs : femur towards the apex somewhat swollen above, so that the apex itself is blunt before the tibia. Lower femoral edge not greatly convex ; straight on basal half, followed by a row of denticles (23 only) running over two slight flat lobes. Hind tibia a little swollen outwardly towards the apex.

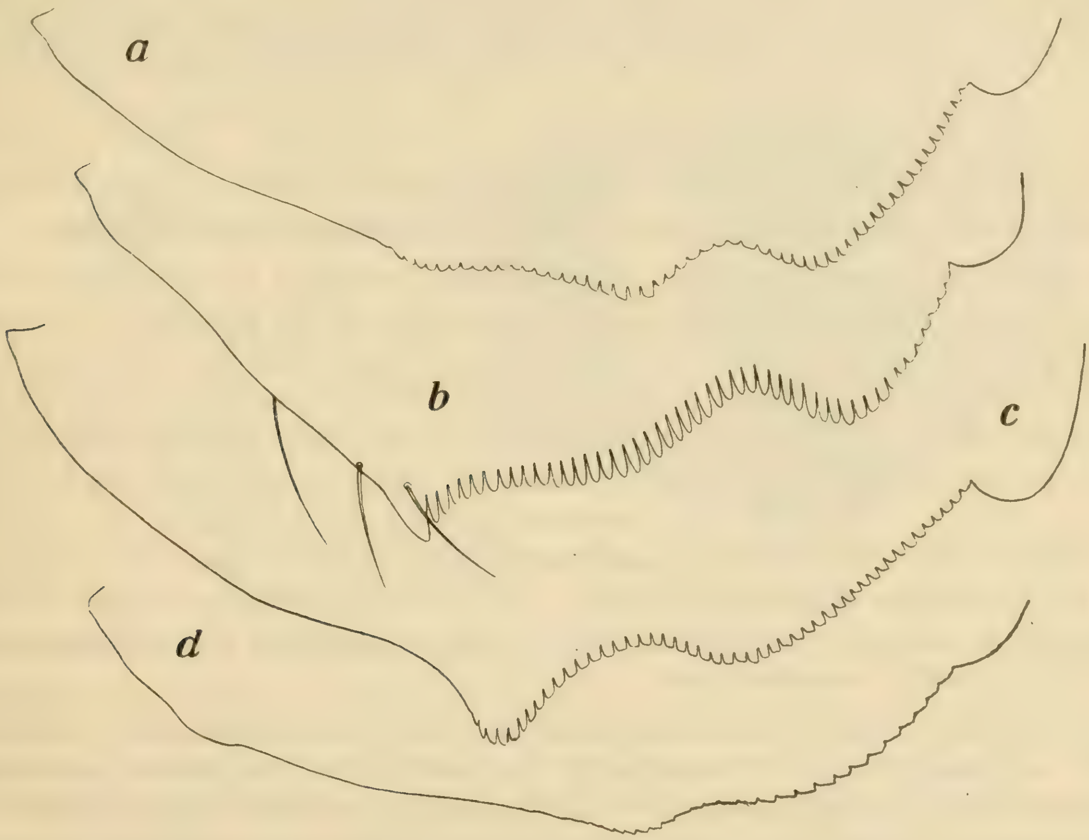

Fig. 2. Lower edge of hind femur of :—*a, Stomatoceras micans,* Wtrst. ; *b, Hockeria munda,* sp. n. ; *c, Stomatoceras octodentata,* Cam. ; *d, Haltichella edax,* sp. n.

Abdomen : first tergite covering two-fifths of the length of the whole ; tergites i. to iv. in the ratio 16 : 6 : 5 : 4. First tergite smooth, shining at the sides, but medianly coarsely punctate ; the punctate area triangular, based on the suture, with the apex slightly behind the petiole. Second tergite broadly smooth near the suture with the first, and posteriorly coarsely punctate. The remaining tergites punctate, only the sutures shining.

Length, 4¼ mm. ; alar expanse, 7 mm.

Type a ♂.

Nyasaland : Monkey Bay, Lake Nyasa ; bred from a puparium of *Glossina morsitans,* 3.vi.15 (*Dr. W. A. Lamborn*).

Genus Stomatoceras, Kirby (1883).

Stomatoceras micans, Wtrst. (1915).

S. micans, Waterston, Bull. Ent. Res., vi, pt. 1, p. 69, figs. 1, 2 (1915).

Nyasaland: Monkey Bay, Lake Nyasa; 3 ♀♀ from puparia of *Glossina morsitans*, 1.vi.15 and 11.vii.15 (*Dr. W. A. Lamborn*).

Compared with the type, which is evidently undersized, these examples are altogether more robust. In length they run from $4\frac{1}{2}$ to 5 mm. (as against 4 mm.), but the alar expanse would appear to be constant at about 6 mm. The tegulae, apices of the hind femora and the tibiae are somewhat more infuscated, and the wings are darker than in the N. Rhodesian example.

The pattern of the propodeon, to which special attention was not drawn in the original description, consists of a large median cell divided by a moderately raised central ridge. The sides of the cell are formed by strong carinae from which run two series of cells—about eight in the anterior row behind the metathorax, and six to seven posteriorly. There are thus two irregular transverse ridges on each side of the central cell, one from about the middle to near the spiracle, and the other from the side of the petiolar insertion to the major lateral projection. In the Nyasaland specimens, the cells of the propodeon are slightly more elongate than in the type.

As regards the pubescence, my previous notes may stand (p. 71), with the following modification:—Except along the antero-lateral edge of the pronotum, the dorsal clothing of the thorax is golden or tawny. In all larger Chalcids, even when bred, the pubescence of this region is fugacious, but in one specimen it has been brilliantly preserved, not only on the sutures, but partially on the surfaces of the lobes as well. Unless in the case of freshly emerged material, too much reliance should not be placed on this character, for in the type specimen hardly a trace of yellow now remains, the fading having occurred in less than five months. *S. micans* may now be regarded as a regular parasite of *Glossina morsitans*. It will be of interest to ascertain whether the species is confined to one host (or host genus), or whether it affects Diptera more generally, or other insects as well.

Along with *S. micans*, there were bred 3 ♀♀ of a new Haltichelline, described below, and assigned in the meantime to the same genus. As regards non-specific characters these examples differ from the genotype *S. liberator*, Walk. (1862), only in the armature of the hind femur and the pattern of the wing (see description and figs.). It is on such differences that the validity of Cameron's *Centrochalcis* (1905) will ultimately have to be based, should the group of species so distinguished prove worthy of generic separation; for I am convinced that in dealing with the Haltichellines one cannot use successfully the *number* of antennal joints (though not the proportions) for taxonomic purposes. Whether *Centrochalcis* be allowed to stand or not, Cameron was at the time of its founding (1905) under a misapprehension with regard to the armature of the propodeon of *Stomatoceras*, Kirby. It may also be remarked that while *Centrochalcis*, Cam. (1905), is a true Haltichelline, *Centrochalcis*, Cam. (1913), is undoubtedly a Chalcidine, which I cannot at present separate from *Trigonura*, Sichel (1865). I have examined Cameron's genotypes in both instances.

Stomatoceras (Centrochalcis) exaratum, sp. nov.

Distinguished chiefly by the colour and the sculpture of the propodeon.

♀. A very dull black species, nowhere paler from the dorsal aspect and with the ventral surface nearly as dark, only the edges of the sclerites obscurely brownish, ovipositor hardly appreciably lighter below. Abdomen shining only on a portion of the 1st and 2nd segments. Antennae: scape brown, or medianly extensively blackish brown, lighter at base and apex; 1st funicular wholly clear reddish brown, 2nd like the first but narrowly darker dorsally and apically; remainder of the antennae nearly black; the extreme tip of the club obscurely paler in transmitted light. Wings: veins blackish brown; below the marginal and the uprise of the submarginal is a blackish brown band or cloud stretching to the posterior margin, before which it slopes towards the apical edge. Outside the dark area is a clear band descending straight at first below the end of the radius, then curving forward at about half-way to the posterior angle of the wing, before which it ends indefinitely; between this clear band and the broadly pale apex of the wing is a second blackish brown cloud,

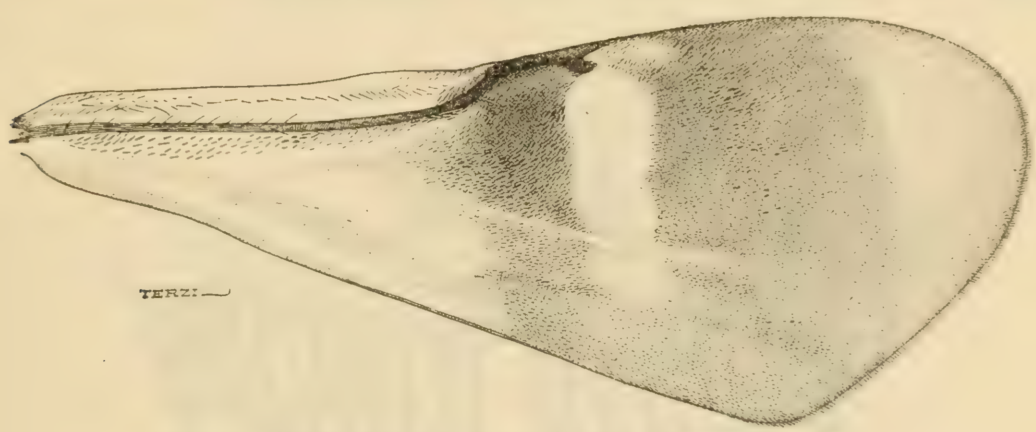

Fig. 3. Right wing of *Stomatoceras exaratum*, sp. n.

lighter posteriorly. Hind wing hyaline. Legs: all coxae black; fore and mid legs castaneous or reddish brown, only the claws and empodia black. Hind legs with the trochanters dark chestnut, this tint continuing mainly on the base of the femur outside, and along the ventral edge half-way to the median prominence, also on apex; femur otherwise black externally; internally the basal two-thirds black, merging gradually to castaneous at the apex. Tibia blackish brown, darkest along the lower edge, where it folds against the femur; tarsi dark castaneous. Pubescence generally silvery, refringent, but light tawny on the apex of the tibia and on tarsus of hind legs.

Head triangular from in front; breadth : depth, as 15 : 13; base line of the eye cutting the mid line at two-thirds. Orbits not very divergent; eyes at the base separated by two diameters, on the vertex by one and a half; eyes shortly and slightly pubescent. In width the head just exceeds the prothorax and about equals the abdomen, but is distinctly less than the distance between the extended tegulae (cf. *S. micans*). The punctures of the head bear, as on the thorax, minute stout silvery bristles, which form a definite row only along the orbits. *Antennae* twice the distance between the vertex and clypeal edge; length, 2·8 mm. Scape fourteen times as long as broad, and only a little shorter than the five succeeding joints;

pedicel one-fourth of scape, slender, length one-fourth (at the base) to one-third (at the apex) of the breadth. Joints from the scape onwards in the ratio 21, 10, 21, 18, 17, 16, 14, 13, 12 ; club 21, with only the first septum distinct, but probably in ratio 2 : 2 : 1 ; club not wider than the preceding three joints ; length to breadth, as 7 : 3 ; funicle as a whole nearly cylindrical ; the widest joints only one-eighth greater than the first, which bears only two or three sensoria at the upper apical angle. On all the succeeding joints the sensoria are numerous.

Thorax: the surface between the thimble-like punctures is rough, reticulate, the punctures setigerous, but most of the dorsal bristles fugacious. Scutellum broad apically, with widely divergent teeth whose inner edges contain a rounded obtuse angle. Metanotum : on each side 9–10 transverse, short ridges with quadrate punctures between. *Propodeon* : outside the long central cell are about seven similar cells separated by well-defined ridges which run back without cross-connections to a stout ridge rising at the outer angle of the petiolar hollow and running forward to the first projection behind the spiracle. Behind the ridge a dense long pubescence arises (fig. 4) ; the petiole is broadly based on the propodeon.

Fig. 4. Propodeon of *Stomatoceras exaratum*, sp. n.

Fore wings not quite two and a half times as long as broad ; length, 2·85 mm. ; breadth, 1·1 mm. ; submarginal : marginal : radius : post-marginal, as 20 : 5 : 1 : 1 ; the post-marginal and the radius more exactly as 7 : 5. The submarginal bears 32 bristles up to the pustules at its junction with the marginal. Below the submarginal, from near the base onwards, is an irregular row of scales, which become two to three deep on the uprise to the marginal. Along the lower edge of the marginal, or immediately below, a single row of scales ; on both bands a few scales occur irregularly mixed with stout short bristles. These are more numerous on the first band below the radius at the side of the clear band, and on the middle of the second band. *Hind wings* : length, 2·15 mm. ; breadth, ·65 mm. About eighteen bristles along the base of the costa ; ten to twelve stiff bristles in the frenulum.

Legs resembling those of *S. micans*, and with similar proportions, but the under surface of the hind femur is produced into a deep rounded angular median lobe,

beyond which the edge is nearly straight, then swelling broadly out subapically; from the apex of the lobe the lower edge is minutely denticulate, the denticles numbering rather under fifty.

Abdomen broadly ovate, stout; from above, a line between the stylets and the petiole is cut by the edge of the first tergite in the ratio 3 : 2. The visible edge of the sheath of the ovipositor is one-half the dorsal edge of the preceding tergite. Tergite i. is smooth and shining, but minutely punctate on the posterior one-third especially, and more coarsely on the sides; tergite ii. with the puncturation feeble anteriorly, and more pronounced posteriorly; from tergite iii. onwards the surface is increasingly rougher, on vi. quite coarse and dull. Tergites i.–iii. are bare (mainly in the centre), but on their pleurae and elsewhere the surface is shortly and closely pubescent.

Length, 4–5 mm.; alar expanse, $5\frac{1}{2}$–$7\frac{1}{4}$ mm.

NYASALAND: Monkey Bay, Lake Nyasa; 3 ♀♀ bred from puparia of *Glossina morsitans*, 31.v.15, 27.vi.15 and 9.vii.15 (*Dr. W. A. Lamborn*).

Type, a ♀.

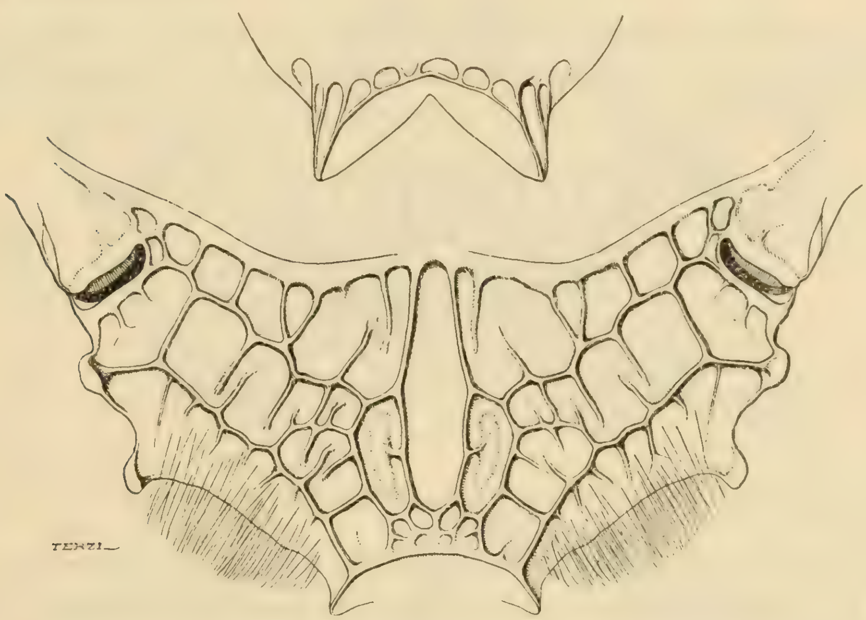

Fig. 5. Propodeon of *Stomatoceras octodentata*, Cam.

S. exaratum comes close to *S. diversicornis*, Kirby, (Journ. Linn. Soc. Lond. Zool., xx., p. 36, 1886) from Kassala, Egyptian Sudan, and *Stomatoceras* (*Centrochalcis*) *octodentata*, Cameron, (Zeitschr. f. Hym. Dipt., p. 230, 1905) from the Transvaal. The three forms may be separated most easily by the shape and sculpture of the propodeon. The colour differences (which are probably not very reliable) are as follows:—In *octodentata* the funicle is more extensively castaneous, only the last two joints and first divisions of the club dusky, while the tip is again paler. The legs are concolorous fuscous or blackish brown, the hind femora nearly black and the knees hardly paler. Kirby's type now lacks both antennae, but according to the description the " scape of antennae and joints 2, 3, 4 and 11 " are " wholly red." All the femora and tibiae are blackish brown; the hind femora distinctly black. Fore and mid

tibiae reddish brown ; hind tibiae apically lighter. Compared with *exaratum* the antennae of *octodentata* are longer and thinner, with the fourth and ninth joints relatively shorter, and the club distinctly so (only three-fourths of the scape), and there are more sensoria (6–7) on the apical half of the first normal funicular joint. Abdomen slender, and so elongate apically, that the stylets cut a line between the posterior edge of tergite i. and the apex of the sheath of the ovipositor at a point 7 : 6. In *exaratum* and *diversicornis* the abdomen is stout and the ovipositor short, so that the stylets lie at a point 16 : 9. The puncturation of the abdomen is variable, but in *octodentata* it is coarse and there are only narrow gleaming sutures between the tergites. The puncturation is finer and the sutures broader in *exaratum*. In the fore wings *octodentata* and *diversicornis* have 24–26 bristles on the submarginal, and the latter species has comparatively few scales, except below the marginal, where they lie 3–7 deep. There are practically none on the subapical cloud. *S. octodentata* has very scaly wings, many scales occurring in incomplete lines on the subapical cloud. Below the submarginal

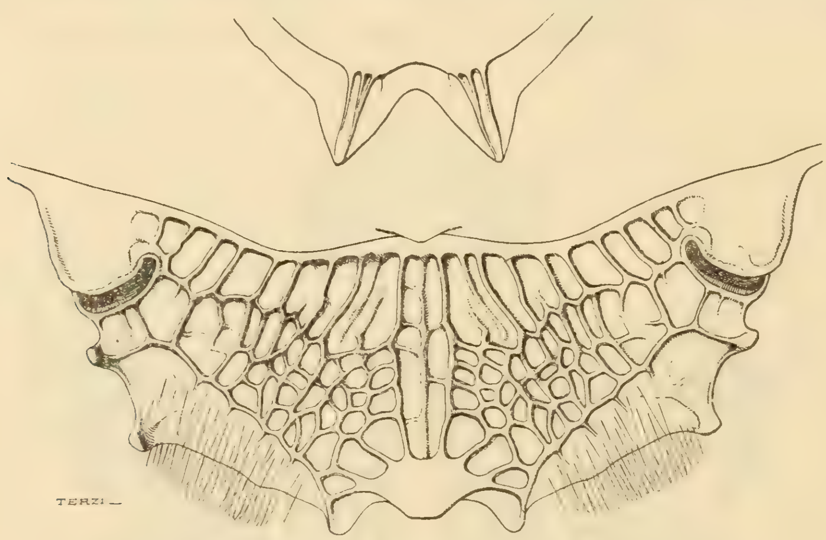

Fig. 6. Propodeon of *Stomatoceras diversicornis*, Kirby.

single scales occur nearly to the base. Near the base of the hind wings *octodentata* has a costal row of about ten minute bristles ; in *diversicornis* there are three times as many bristles in this position. In *octodentata* the straight bristles of the frenulum are about eight, in *diversicornis* twenty-two, in number. In all three species the structure of the hind legs is the same. Kirby's description of the under side of the femur : " The middle tooth distinct, the others merely undulations " is misleading. The femur is fringed with minute equal denticles, and there is nowhere a major tooth ; " the middle tooth " referred to being really a femoral lobe and itself edged with denticles (fig. 2, *c*).

Family ENCYRTIDAE.

Genus Eupelminus, D. T.

Eupelminus, Dalla Torre, Wien. Ent. Zeit., xvi, p. 85 (1897).

This genus, which comprises at present wingless Eupelmines with normal fore femora, straight-margined abdominal tergites and an unprojecting ovipositor, not improbably contains the apterous members of more than one genus. But the

category is convenient to use, and until the thoracic structure of its various components is better understood, any subdivision is inadvisable. Dr. Lamborn has reared a remarkable ♀ of this group, which I have described as fully as the condition of the specimen admits. Unfortunately the abdomen has been damaged, and one of the legs and an antenna are incomplete. The outline of the second and third tergites is thus not quite certain. The specimen moreover, has died in the characteristic Eupelmine (♀) pose, with the head thrown back to the fullest extent and the abdomen uplifted. It has not been possible to effect complete relaxation, but Mr. Terzi's patience has overcome many obstacles, and the outline figure he has supplied is thoroughly satisfactory (fig. 8). The long sclerite below the axilla is apparently the tegula (T) and the two minute triangular areas before this plate and the axilla are membranous. The large size, banded antennae, moulding of the head, tridentate mandibles, and the peculiar post-ocular bristly sulcus, along with the structure of the thorax and stout abdominal tergites, render this species easily recognisable.

Eupelminus tarsatus, sp. nov.

♀. A large dull brownish to brownish black species, with (in the single type specimen) few metallic reflections. These occur as follows :—above the clypeus, faint bronzy ; on the frons, between and near the scrobes, a slight violaceous lustre ; on the genae,

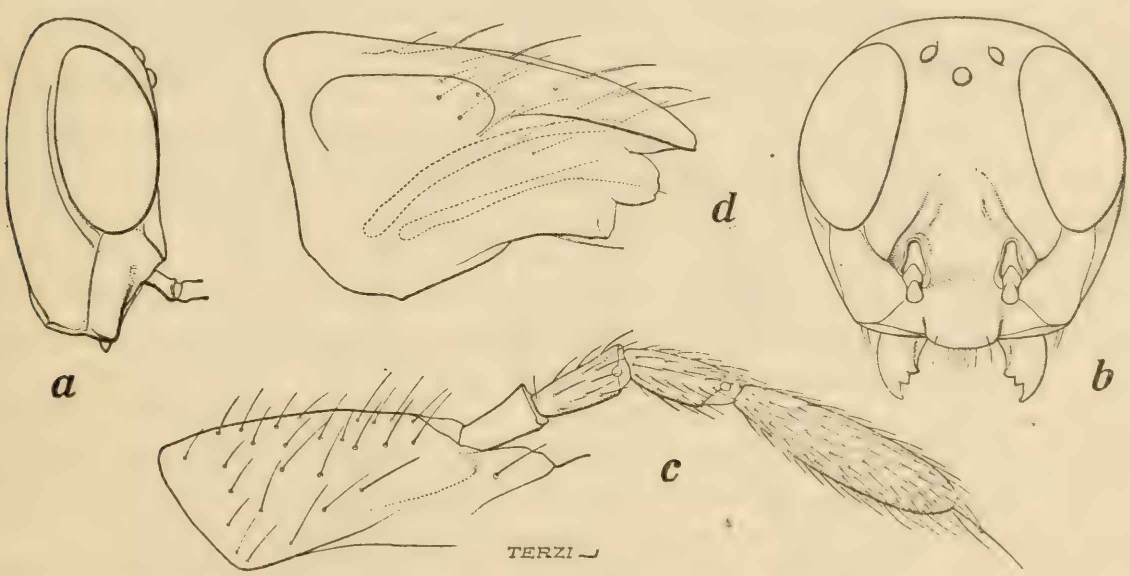

Fig. 7. *Eupelminus tarsatus*, sp. n. ; *a*, head, profile ; *b*, head, front view ; *c*, stipes and maxillary palp ; *d*, mandible.

behind the eyes, and malar keel, faint dark green ; on the mesonotum, chiefly on the inside of the lateral ridges, and again on the upper surface of the hind coxae, dark blue. Seventh antennal joint (except the base), eighth entirely, and ninth (except the apex), pale, nearly white. The entire fore and hind legs (except the first tarsal joint, which is yellowish white), are blackish brown ; mid legs like the others, but not so dark as the hind legs and with the first two tarsal joints narrowly pale above. Pubescence on the dorsum of the abdomen brown, on the sides whitish.

Head just deeper than broad ; eyes (×88) very shortly pubescent, approximated towards the vertex, widely separated towards the mouth, so that the base line of the eyes is twice the shortest distance across the vertex ; ocelli occupying rather more than the median third, and so far advanced that even the posterior pair lie on the anterior

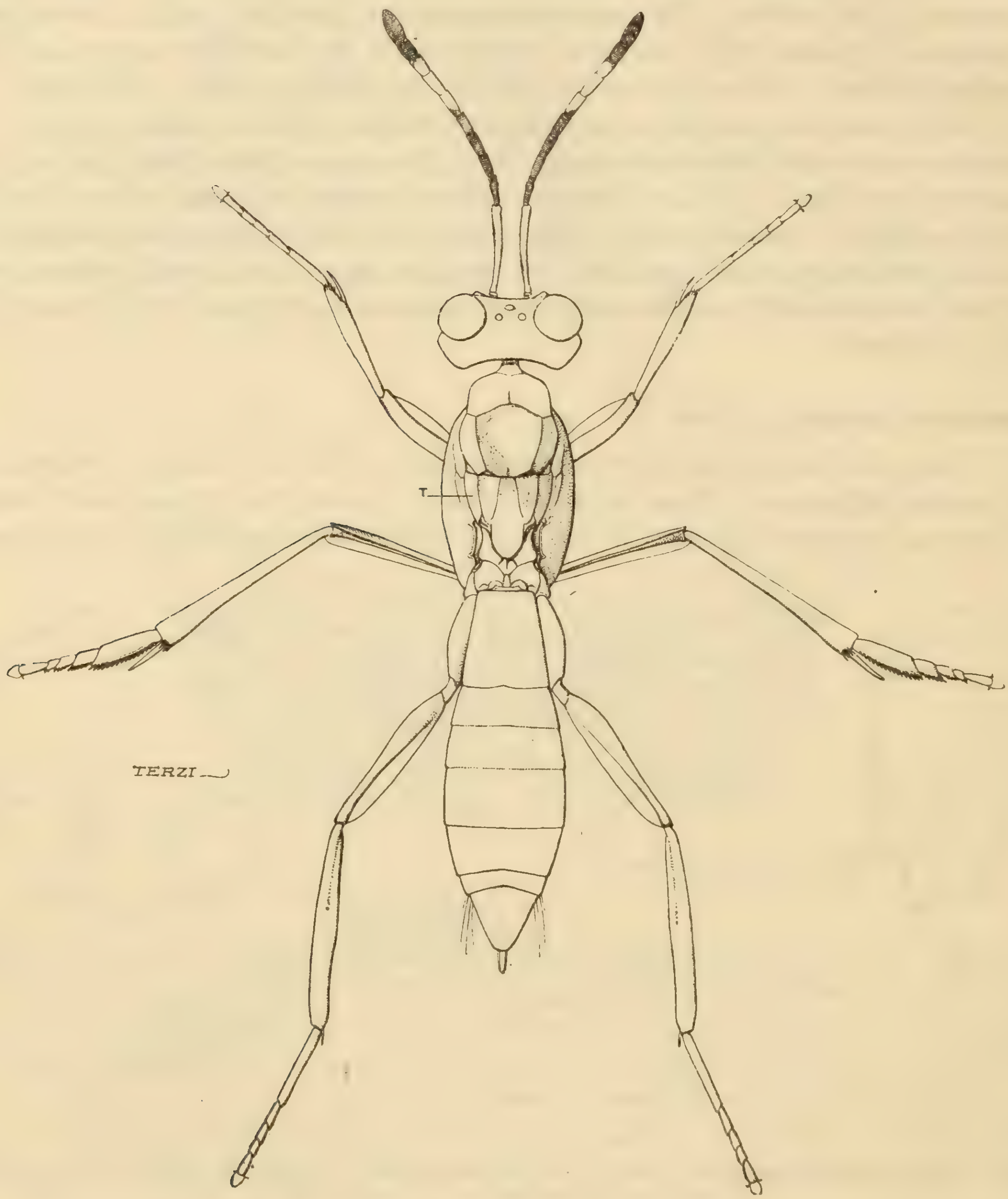

Fig. 8. *Eupelminus tarsatus*, sp. n., ♀.

slope towards the frons. Scrobes long, triangular, their longest diameter running with the depth of the head, just outside a line drawn from a corner of the clypeal edge to the corresponding lateral ocellus. The lower rim of the scrobes lies half-way between the clypeal edge and the base line of the eyes, while the upper angle is still below that line. Mouth-edge wide and straight, the clypeus advanced as a straight narrow median border. Malar keel fine ; behind the eye from the keel to near the vertex runs a distinct sulcus bearing short glistening bristles. Below the ocelli the

frons is level, except where interrupted by the post-scapal hollow. This depression, extending half-way from the scrobes to the anterior ocellus is on the lower two-thirds deeply sunk at the sides, with sharply excavated walls, and medianly raised between and behind the scrobes. At the apex it is broadly rounded, merging gradually with the frons. There is another well defined edge, with a deep fall towards the malar keel and the mouth-edge, between the eyes and the scrobes. The whole surface of the head is finely reticulate, the pattern more flowing or striate on the post-scapal hollow.

Mouth-parts ; labrum with six bristles ; mandibles similar, broad and stout, narrowing apically, with three teeth, the lowermost acute, the middle one rounded, and the uppermost nearly rectangular. Three rows of bristles externally on the lower apical two-thirds. Maxillary palpus : stipes elongate, with thirty to forty bristles, mainly on the outer side ; palpus (5 : 6 : 7 : 15) with the first joint *bare*, and at its base, one-third of the last joint at its widest ; joints 2–4 covered with short stiff bristles, 2 and 3 bearing in addition a large clear pustule (sense organs ?). There are two or three strong hyaline terminal bristles (the longest not one-fourth of the last joint) and one stout hyaline spur. The mentum bears about eighteen bristles. Labial palpus (6 : 1 : 6) with all the joints bristly and the last swollen, the terminal bristle two-thirds as long ; the lingua bears about twelve setigerous cells.

Thorax : the whole surface refringent, unless otherwise noted, raised reticulate and mostly with minute scattered glistening appressed bristles. Prothorax porrect ; pronotum with two somewhat quadrate sclerites ; pre-episternite covered by overlap of protergite and smooth. Mesonotum flat above, with sharp ridges (parapsides ?) laterally. Side lobes curving downwards to the mesopleurae and nowhere dorsally flattened. Scutellum about the same length as the mid lobe, but from above apparently longer, as the thorax slopes more abruptly forward from the suture. The abscissa of the scutellum on the suture is less than the width of either axilla, and the bases of the scutellum and the axillae form a straight line. The sclerites of the axillae, and the mid and side lobes do not fit perfectly, the gap between being triangular. Axillae slightly over two-thirds the length of the scutellum, and in the same plane. Prepectus narrow and wedge-like, based posteriorly on the narrow and short mesepisternite, which lies below the very large tegula. On the mesopleurae the short bristles are placed principally antero-ventrally. Apically the scutellum is developed at the sides into two short rounded lobes ; here the tips of the tegulae and the sharp entero-lateral angles of the metanotum rest. Surface of the scutellum towards the apex coarser in texture ; metanotum and propodeon smoother and almost shining, though distinctly reticulate. Metanotum in the form of two triangular sclerites broadly joined medianly and reaching far forward ; at their junction is a short keel and traces of two others, one on each side. Propodeon like the metanotum, in two sclerites, with large antero-lateral spiracles opening anteriorly.

Legs : fore femur only moderately thick ; apparently without ventral fringe of long bristles. The mid tibial spur is about five-sevenths of the first tarsal joint, which bears nineteen teeth anteriorly and sixteen posteriorly ; the second has 6, 7 ; the third 4, 4 ; and the fourth 1, 1. There are also four teeth at the apex of the tibia anteriorly. In the hind leg, the tibia folds up flatly against the femur, which is posteriorly smooth and slightly grooved along its entire length. The apical tibial spur is short. In all the tarsi the proportions approximately are :—10, 5, 3, 2, 3.

The claws are minute. The first fore tarsal is nearly two-thirds the first hind tarsal joint. All the legs are long; the extended mid leg about three-fourths of the length of the insect. *Abdomen*: all the tergites sclerosed and with the proportions given in the sketch; the first tergite medianly shallowly incised; the others probably straight-edged. Anteriorly the pubescence is sparser, but dense posteriorly (from the fourth segment). Ovipositor slightly protruding.

Length about 5 mm.

Type a ♀.

NYASALAND: Monkey Bay, Lake Nyasa; bred from puparium of *Glossina morsitans*, 30.v.15 (*Dr. W. A. Lamborn*).

Family: *EULOPHIDAE.*

Syntomosphyrum glossinae, Wtrst.

S. glossinae, Waterston, Bull. Ent. Res., v, pt. 4, p. 365, figs. 14–16, and ibid. vi, pt. 1, p. 81 (1915).

This species has now been shown by Dr. Lamborn to be a hyper-parasite of *Glossina morsitans* through *Mutilla glossinae*, Turn.

NYASALAND: Monkey Bay, Lake Nyasa; 13 ♀♀ bred from a puparium of *Glossina morsitans*, 17.vi.15 (*Dr. W. A. Lamborn*).

These are presumably part of the parent stock from which Dr. Lamborn conducted the breeding experiments noted below. The numbers of each sex detailed are those actually received by the Bureau.

"These tiny Chalcids were bred from two female parents which with the male parents also emerged from the same pupa. Coitus 20.vi.15."

125 *a*. Tsetse pupa parasitised by Mutillid on 17.vi.15. Chalcid at work on it on 23.vi. Offspring emerged on 27.vii, eleven in all.
11 ♀♀ (34 days).

125 *b*. Pupa parasitised by Chalcid on 24.vi; offspring, eighteen in all, emerged on 27.vii.
15 ♀♀ (33 days).

125 *c*. Pupa operated on by Chalcid on 25.vi. and offspring—thirteen—emerged on 29.vii.
13 ♀ (34 days).

125 *d*. Pupa operated on by Chalcid on 27.vi. and offspring—thirty-six—emerged on 29.vii.
7 ♂, 24 ♀ (32 days).

125 *e*. Pupa which was then chipped and showed the cocoon of the Mutillid, was operated on by the Chalcid on 28.vi., and the Chalcid's offspring, 29 in all, emerged on 1.viii.
1 ♂, 28 ♀ (34 days).

125 *f*. Pupa was operated on by the Chalcid on 25.vi., and the offspring, numbering 32, came out through the holes on 2.viii.
1 ♂, 31 ♀ (38 days).

125 *g*. Pupa was operated on by the Chalcid on 26.vi., and the offspring, numbering twenty-three, came out through two holes on 4.viii.
2 ♂, 20 ♀ (39 days).

125 *h*. Pupa operated on by the Chalcid on 2.vii, and the offspring, numbering twenty-one, emerged on 6.viii.
4 ♂, 17 ♀ (35 days).

Of the specimens received the males are just over 7 per cent. of the whole. The average length of the life-cycle from egg to imago would appear to be five weeks.

In these Nyasaland *S. glossinae* the coloration is richer than in the type, the pedicel and funicular joints being dark and the club as a rule entirely pale.

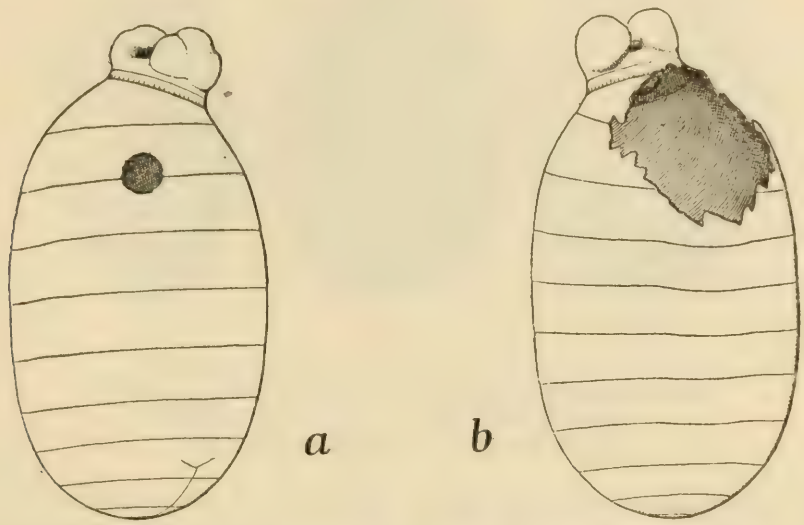

Fig. 9. Puparia of *Glossina* showing holes of emergence of: *a, Syntomosphyrum glossinae*, Wtst.; *b, Stomatoceras micans*, Wtst.

Emergence of parasites (fig. 9). The aperture made by *Syntomosphyrum* is small and circular. In six out of eleven puparia examined, the entire brood has used the same hole. In another, two holes, one anterior and one posterior, have been pierced; in another, two holes approximated, forming an 8-shaped aperture. In the rest the original hole has been enlarged and has become irregular. *Syntomosphyrum* emerges indifferently at any point on the puparium.

Stomatoceras spp. apparently prefer an exit gnawed posteriorly. In four out of five puparia examined the hole is in this position. The aperture is large, very irregular, without any distinctive feature. That of *Eupelminus* differs only in being smaller.

ON A COCCID INJURIOUS TO PINE TREES IN THE HIMALAYAS.

By E. E. Green, F.E.S., F.Z.S.

(Plate XVII.)

Ripersia resinophila, sp. nov.

Adult female (as observed in specimens preserved in alcohol) broadly oval (fig. 1, *b*, *c*), strongly convex (fig. 1, *a*), circular under compression ; divisions of segments

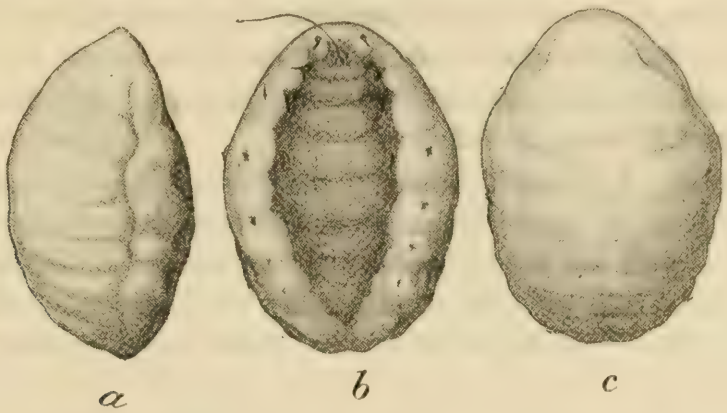

Fig. 1. Adult female of *Ripersia resinophila*, Green, sp. n., × 9 ; *a*, lateral view ; *b*, ventral view ; *c*, dorsal view.

indicated on the dorsum by moderately deep transverse furrows : marginal area tumescent, overlapping the ventral area (fig. 1, *b*). Colour (of alcoholic material) ochreous, brownish, or olivaceous, very thinly powdered with white mealy secretion.

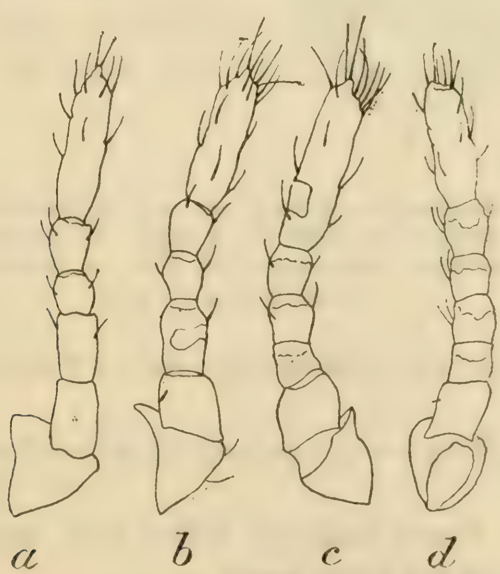

Fig. 2. Antennae of *Ripersia resinophila*, × 210 ; *a*, normal 6-jointed form ; *b*, *c*, intermediate forms ; *d*, 7-jointed form.

Antennae very small : 6- or 7-jointed (fig. 2, *a*, *d*), with intermediate forms showing incomplete division of the 3rd (fig. 2, *b*) or of the 6th (fig. 2, *c*). Antennal formula of normal 6-jointed form, 6, 2, 3, 5, 4, the 6th twice as long as the 2nd. In the 7-jointed

form joints 3, 4, 5 and 6 are approximately equal. Legs very small and feeble: tarsus approximately equal to tibia (fig. 3, *a*): digitules filiform, minutely knobbed at extremity. No anal lobes, the posterior extremity evenly rounded. Anal ring fig. 3, *b*) circular or oblate, bearing six short and inconspicuous setae united by a chain of ceriferous pores. Derm with small and inconspicuous circular pores, on the posterior segments only. Diameter of fully matured examples 3·50 to 4·0 mm.

Early adult female (containing developing embryos) very much smaller, scarcely one-eighth the size of fully matured individuals: longer diameter 1·50 mm. At this stage the insect is subspherical in outline, the anterior extremity produced into a blunt point. The junctions of the abdominal segments, in these younger females, are often marked by series of irregular thickened ingrowths of the derm.

I have been unable to recognise the true nymphal stage. All the smaller examples examined contained developing embryos.

Larva oblong oval. Antenna 6-jointed: the joints rather contracted in the newly hatched insect (fig. 3, *c*), more elongated in the later larvae (fig. 3, *d*). Posterior extremity (fig. 3, *e*) with the anal lobes scarcely prominent: their position indicated by short setae. Anal ring with six slender setae which are relatively longer than in the adult insect. Derm with scattered circular pores and very short hairs.

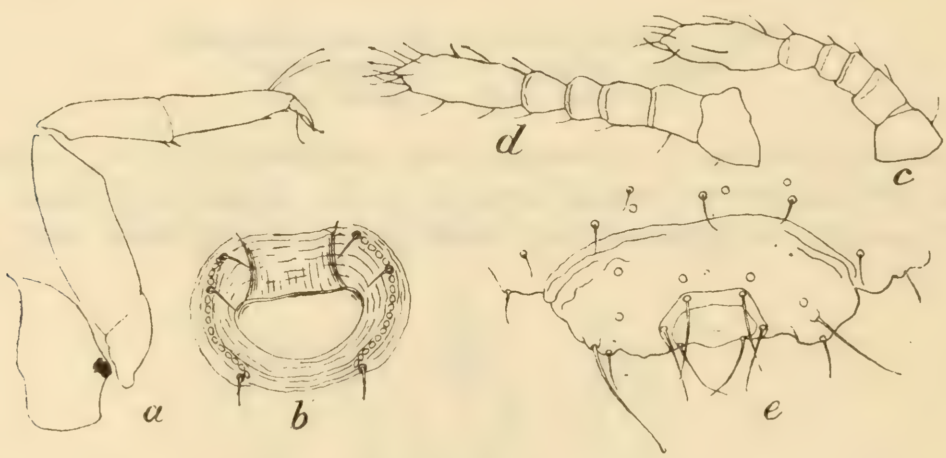

Fig. 3. *Ripersia resinophila*, Green, sp. n.; *a*, anterior limb of adult ♀, × 210; *b*, anal aperture of adult ♀, × 450; *c*, antenna of young larva, × 210; *d*, antenna of older larva, × 210; *e*, posterior extremity of young larva, × 375.

On *Pinus longifolia*, Kumaon Himalayas; and on *Pinus excelsa*, Kamraj Division, Kashmir.

The living insect is said to occupy gummy (? resinous) cells on growing shoots of the plant.

Mr. C. F. C. Beeson, Forest Zoologist, Dehra Dun, supplies the following notes descriptive of the colour of the living insect:—

"Colour of adult female, during gestation, reddish ochreous, with a smooth glossy surface. After extrusion of the eggs the colour passes to reddish brown and finally to brownish purple, the surface becoming dull and wrinkled.

"Colour of egg lemon yellow; surface 'matt,' owing to closely adherent white mealy powder.

" Newly emerged larva also yellow, soon changing to pale pink. On leaving the female cell and settling on the needles the larvae are pale salmon pink, and covered with a white waxy powder."

Dr. A. D. Imms, who had personal experience of the insect in India, adds the following observations :—

" My attention was first called to the insect by Mr. C. M. McCrie, a forest officer, who noted it at Binsar. It attacks young plants up to about 8 feet high mostly. It is a very destructive insect and the adult female is coated externally with a thick gummy investment extremely like—in colour and appearance—to gum arabic. The young Coccids on hatching at first crawl up the twigs and ensconce themselves between the pine needles and feed thereon, and for that reason are hard to find. Later on they settle down on the growing twigs themselves. In wet weather the gummy covering of the insect becomes soft and sticky, and a fungus germinates readily on it and produces a black appearance which at first sight appears to belong to the Coccid. I found it very abundant at Takula, Binsar, Bhowali and Ramgarh (all in Kumaon) at elevations of 4,000 to 5,800 feet. It appears to be commonest on hot sunny hill-sides. Badly affected trees grow very little in height, only in thickness. It is not, however, absolutely confined to young plants; I have had branches cut off large trees at a distance of 50 feet from the ground, and found the scale thereon, but not plentifully. It is much attacked by Coccinellidae and parasitic Hymenoptera, and ants swarm on badly affected trees."

It is not clear whether the " gummy cells " are secreted by the insect or whether they are composed of an exudation from the plant. I have not examined these cells, specimens sent from India having been lost in transit. The derm of the adult insect displays no special glands such as might be expected if the gummy matter were produced by the creature itself.

I place the species in the genus *Ripersia* with some hesitation. The characters are not exactly typical, but agree more nearly with those of this than of the allied genus *Pseudococcus*.

Fig. 1. Healthy young Chir Pine (*Pinus longifolia*), 6 ft. 5 in. high.

Fig. 2. Young Chir Pine, 6 ft. high, badly attacked by *Ripersia resinophila*, Green, sp. n.

NOTES ON SAMOAN COCCIDAE WITH DESCRIPTIONS OF THREE NEW SPECIES.

R. W. Doane and G. F. Ferris,
Stanford University, California.

During a recent visit to Samoa the senior author had an opportunity to collect a few Coccidae. No time was available to make a systematic search for these insects and the specimens collected were only such as were seen in the course of other work. As a list of these has been asked for, it seems desirable to publish the following brief notes with the descriptions of the three apparently undescribed species.

The collection includes the following species :—

Asterolecanium bambusae, Bdv. Very abundant upon bamboo.

Coccus frontalis (Green), *Coccus viridis* (Green), *Lecanium psidii*, Green, *Pulvinaria psidii,* Mask., on unidentified plants.

Ceroplastes rubens, Mask. Extremely abundant on mango.

Saissetia nigra (Nietn.). Host unidentified.

Saissetia oleae (Bern.). Common on oranges and several other plants.

Saissetia hemisphaerica (Targ.). On several different hosts.

Eucalymnatus tessellatus (Sign.). On unidentified host.

Chionaspis citri, Comst. Very abundant on orange.

Chionaspis samoana, sp. n.

Female scale white, elongated, widened posteriorly. Exuviae yellowish. Length of scale approximately 1·5 mm. Male scale not identified.

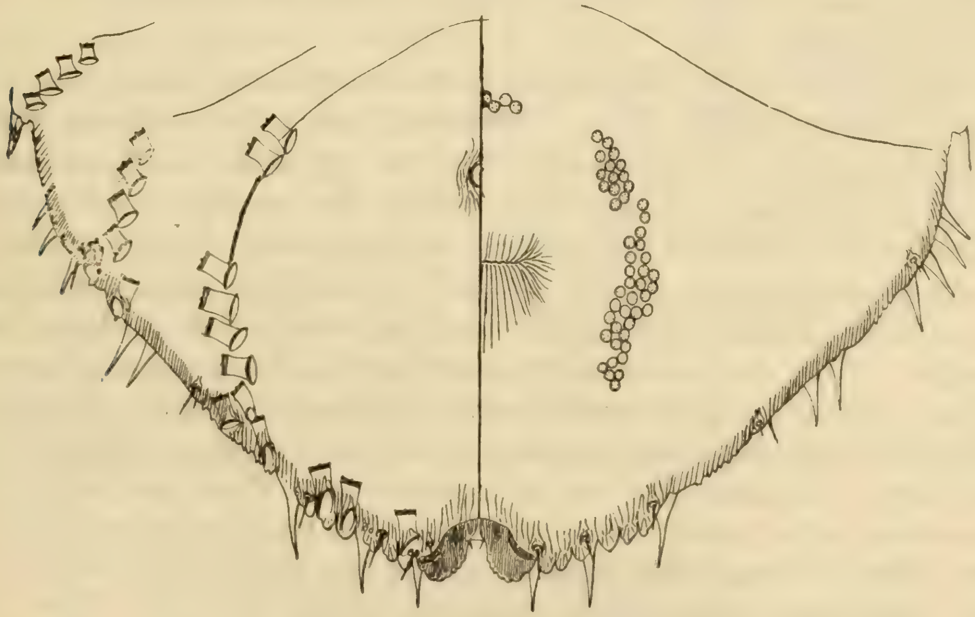

Fig. 1. Pygidium of *Chionaspis samoana*, sp. n.

Adult female elongated, about three times as long as wide. Abdomen slightly constricted between the segments. Three pairs of well developed lobes present. Median lobes conspicuous, their mesal margins fused for a short distance and then diverging rapidly. Discal margin rounded or slightly truncate and crenate. Second

and third pairs of lobes with two lobules which are nearly of the same shape and size. Lobules of the third pair of lobes short, broad, lateral margins finely crenate. Between the first and second lobes is a gland-bearing prominence, which in size and shape closely resembles the first lobule of the second lobe ; between the second and third lobes is a similar but broader lobule-like prominence. There is a conspicuous gland spine (plate) between the first and second lobes, one between the second and third lobes, and one just beyond the third lobe. Near the anterior margin of the pygidium is a group of four gland spines and about half-way between these and the third pair of lobes are two more gland spines situated close together. The marginal spines of the dorsal side are near the lateral angles of the bases of the first and third pair of lobes and near the incision of the second pair of lobes. Circumgenital gland orifices in five groups, the cephalic group with four to six, the anterior lateral groups with about fifteen, the posterior-lateral groups with about thirty. The anterior and posterior lateral groups are, in some specimens, almost confluent. Dorsal gland orifices in three rows, the two anterior rows each consisting of four or five glands, the posterior row divided into two groups, of which the anterior contains two and the posterior four or five orifices.

On a species of palm, concealed beneath the woolly covering of the stems.

Hemichionaspis aspidistrae (Sign.). Very abundant upon several different hosts, including palm, banana and orange. There is a wide range of variation among our specimens, so much, in fact, that it seems doubtful if all should be referred to the same species. However the extreme forms are apparently all connected to the others by intermediate stages. A thorough study should be made of the group, using abundant material from various localities and host plants.

Aspidiotus cydoniae, Comst. On orange and an unidentified plant.

Aspidiotus pangoensis, sp. n.

Female scale circular or sub-circular, flat and rather thin and chaffy, of a brownish grey colour. Exuviae central, yellow. Diameter 2 mm. Male scale not identified.

Adult female pyriform or sub-circular, with the pygidium usually somewhat retracted into the abdomen. Body-wall, especially the margins, thickly chitinized and brown in colour, except for the pygidium which is clear. Length 1·2 mm.

Three well developed pairs of lobes present. Median pair heavily chitinized and conspicuous, rather slender, close together and with their mesal and lateral margins nearly parallel. From the base of each a short club-shaped thickening extends into the pygidium. Distal margins rounded, with a single slight notch. Second pair of lobes as long as or even longer than the first, of the same width and shape, but being much less heavily chitinized they are less conspicuous. Third pair about half the size of the second and of nearly the same shape. The marginal spines are arranged as follows: On the dorsal side there is one at the outer angle of the base of each lobe; and two, quite widely separated, beyond the third lobe; on the ventral side there is one at the outer angle of the base of the second and third lobes and two beyond the third lobe. The plates are as follows : Two with fringed tips between the median lobes, and two similar but wider ones between the first and second lobes ; three with deeply cleft tips between the second and third lobes and five or six beyond the third pair of lobes, the first three of these being deeply divided, the remainder simple.

Grouped gland orifices either entirely wanting or present in two groups of but one or two to the group. From each group a very narrow chitinized strip extends posteriorly to meet a rather narrow, slightly chitinized area which extends in from the bases of the median lobes. Dorsal tubular spinnerets rather slender, irregularly scattered over the pygidium but a little more abundant posteriorly. Anal orifice about two-thirds of the way between the margin and the vaginal orifice.

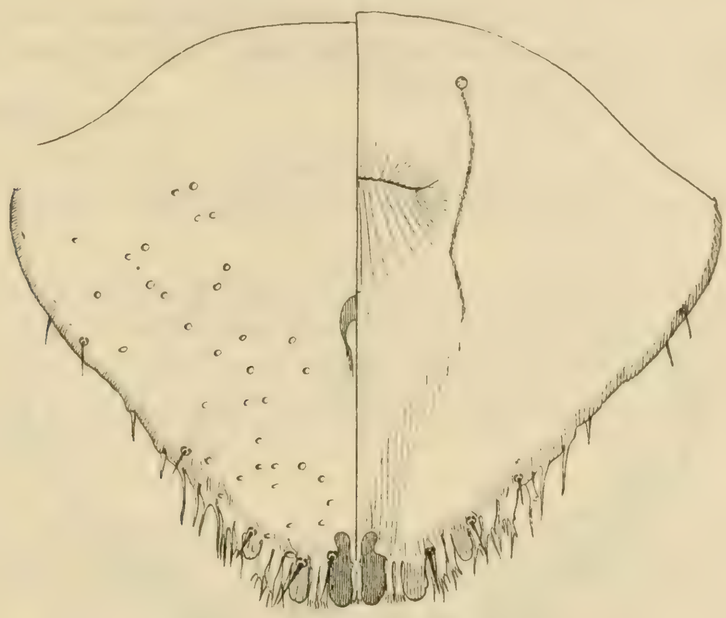

Fig. 2. Pygidium of *Aspidiotus pangoensis*, sp. n.

On cocoanut husks at Pango Pango and on an unidentified plant.

This species somewhat resembles *A. destructor*, Sign., but the scale is rather heavier and darker in colour, the body-wall more heavily chitinized, the lobes more distinct, the plates with fewer serrations. The ducts of the dorsal glands on *A. destructor* are rather long and most of them open on the margin, those of *A. pangoensis* are short and most of them open on the dorsal surface. Although we have examined many specimens we find the grouped spinnerets entirely absent or represented by a single gland on each side.

Chrysomphalus rossi (Mask.). On cocoanut husks at Pango Pango.

Odonaspis secreta, Ckll. Common on bamboo.

Lepidosaphes beckii (Newm.). Very common on orange.

Lepidosaphes gloverii (Pack.). On orange; apparently much less common than *L. beckii.*

Lepidosaphes moorsi, sp. n.

Female scale elongated, widened posteriorly and usually somewhat curved, almost always concealed beneath the epidermis of the bark of the host plant. Colour brown. Length 2 mm. Male scale not identified.

Adult female elongated, tapering toward the anterior margin, abdomen somewhat constricted between the segments. A single pair of lobes present which resemble very much the lobes of *Howardia biclavis*, Comst. They are rather triangular in shape, the mesal margin being shortest and the distal margin longest and finely

crenate. From the base of each a conspicuous club-shaped thickening extends into the pygidium, and this in turn is surrounded by a rather irregular area which is somewhat more heavily chitinized than the remainder of the pygidium. The characters of the margin of the pygidium are as follows: Laterad of the median lobes a gland pore on a slight prominence, followed by a narrow thickening; a spine on both dorsal and ventral sides; two broad, tapering gland spines; two gland pores; a spine on both dorsal and ventral sides; a gland spine; two gland pores; a spine on both dorsal and ventral sides, the one on the dorsum being nearer the median line than that on the venter; a gland spine; a gland pore. All the gland pores except the first are somewhat back from the margin.

Fig. 3. Pygidium of *Lepidosaphes moorsi*, sp. n.

Circumgenital gland orifices in five groups, in which the cephalic group contains four or five, the anterior-lateral five or six arranged in a row, and the posterior-lateral four or five in a cluster. Immediately anterior to the two lateral groups is a narrow chitinized strip.

Vaginal opening about three-fourths the distance between the anal margin and the anal opening. A very narrow, curved, chitinous strip anterior to the anal opening.

Although this scale superficially resembles *Howardia biclavis*, Comst., both in its burrowing habit and in the shape of the median lobes, it is at once distinguished from that species by the presence of the circumgenital gland orifices. It is evidently quite close to *Lepidosaphes erythrinae*, Rutherford, a species recently described from Ceylon, which also has lobes of the same type, but it differs from that species in the absence of plates and spines between the median lobes.

On trunks of orange trees, near Apia.

Mr. H. J. Moors, on whose plantation this and several other of the species recorded here were collected, was untiring in his efforts to aid us in our investigations while in Samoa.

Parlatoria cinerea, Doane and Hadden. Common on orange.

TWO NEW SPECIES OF HAEMATOPOTA FROM THE FEDERATED MALAY STATES.

By Gertrude Ricardo.

Haematopota stantoni, sp. nov.

Type (female) and two other females from Kuala Lumpur (*Dr. A. T. Stanton*) and one female from Selangor, Malacca (*H. N. Ridley*, 1896), this last being in the British Museum collection.

A species belonging to Group II, the legs having no typical rings on the tibiae, but the base of the tibiae is white (see Ricardo, Records Indian Museum, iv, p. 322, 1911). Wing with the apical band single, extending across the apex. Antennae with the first joint nearly as long as the third. Face with a black band under the antennae. A dark brown species.

Length, 8 mm.

Face pale ashy grey, with some silvery white hairs ; the black band extends across from a point touching the eyes, more than half way down the face, below the base of the antennae. *Palpi* reddish yellow on the inside, outside obscured by grey tomentum and with black pubescence, rather stout, ending in a short point. *Antennae*: the first joint dull reddish, stout, as long as the first division of the third joint, with black pubescence ; the second very small indeed, cup-shaped, of the same colour as the first joint, with black hairs ; the third joint long, blackish, the first division covered with dull grey tomentum, the last four divisions dull black. *Forehead* quite a third the width of the head, covered with dull grey tomentum ; the frontal callus shining blackish brown, reaching the eyes, of moderate depth ; the paired spots large, black, touching the eyes and the frontal callus ; unpaired spot small, triangular. *Thorax* olive-brown, covered with appressed yellow pubescence, scutellum identical, shoulders with black hairs, breast covered with grey tomentum and with white hairs. *Abdomen* blackish brown, a distinct, large grey tomentose triangular spot is present on the second segment, which has also a distinct grey tomentose band on its posterior border ; pubescence very scanty, black, a few silvery white hairs on the last segment. *Legs* blackish, the fore tibiae swollen, their basal third white ; all the femora rather obscurely reddish yellow ; the middle tibiae white, black at the apex ; the posterior tibiae white for two-thirds of their length, also a little swollen, the pubescence consisting of long white hairs on the pale-coloured parts, and short black hairs elsewhere ; the middle and posterior femora have a few white hairs below. *Wings* dark brown, with the usual three rosettes and spots ; the apical band is rather concave, reaching from border to border at the extreme apex of the wing ; the second, third and fifth posterior cells with a white triangular spot.

The species is named after Dr. A. T. Stanton to whom the British Museum is indebted for many specimens of Tabanidae from the Malay States.

Haematopota malayensis, sp. nov.

Type (female) and another from Kuala Lumpur (*Dr. A. T. Stanton*).

A species belonging to Group III ; the legs not uniform in colour, but with rings on the middle tibiae only, all tibiae white at base (see Ricardo, Records Indian Museum, iv, p. 331, 1911).

Wing with the apical band single, reaching barely more than half-way across the apex. Antennae with the first joint short, not half as long as the third. The species may be distinguished by the very protuberant large frontal callus, and the forehead is considerably narrowed at the vertex. A small dark brown species. Length, 7 mm.

Face pale ashy grey, with rather long white hairs. *Palpi* yellow, the second joint of almost the same size throughout, ending in a short obtuse point, with short black pubescence. *Antennae* reddish yellow; the first joint more yellow, with black pubescence, cylindrical, hardly more than a third of the length of the third joint; the second joint very small, of the same colour ; the third joint dull reddish, the last four small divisions narrower than the first division. *Forehead* almost half the width of the head anteriorly, and perceptibly narrower at the vertex ; a small black spot between the antennae ; the frontal callus protuberant, shining brown, taking up the entire width of the forehead, nearly as deep as it is wide ; the paired spots large, touching its posterior border ; the unpaired spot represented by a small dark stripe ; the rest of the forehead is covered with grey and yellowish tomentum. *Thorax* dark brown with traces of appressed fulvous pubescence. *Scutellum* covered with greyish tomentum shoulders with black hairs. *Abdomen* brown, rather a brighter shade than that of the thorax, a very distinct triangular grey median spot on the second segment, extending from border to border, all the segmentations very slightly greyish ; there are signs of white-haired spots on the third and fourth segments, elsewhere the pubescence is black. *Legs* reddish yellow ; the fore femora appear darker, having thicker black pubescence ; the fore tibiae whitish, with white hairs, the apical third being black ; tarsi blackish ; the middle tibiae appear blackish, with a pale ring at the base and beyond the middle, but the dark colour appears to be composed of spaces covered with thicker black pubescence, the whole tibiae being really much the same colour as the femora ; the tarsi yellowish at base, then dusky ; the posterior tibiae very similar to the middle ones, but the second ring is hardly distinct (if really present, the species would belong more properly to Group VI), the base of the tibiae being whitish, the rest reddish yellow covered with black pubescence ; tarsi as those of the middle pair. *Wings* with the apical band small, short and irregular in width, reaching only a short way beyond the anterior branch of the third vein ; every cell has a white triangular spot on its outer border ; appendix present, stigma and veins brown.

NOTES ON A COLLECTION OF SPECIES OF TABANIDAE FROM HONG KONG.

By Gertrude Ricardo.

The blood-sucking flies here dealt with were collected in Hong Kong by Dr. H. Macfarlane, the Government Bacteriologist, and Mr. Adam Gibson, M.R.C.V.S., the Colonial Veterinary Surgeon, and were forwarded by them to the Imperial Bureau of Entomology. The collection comprises not many species, but long series of several species, such as *Tabanus rubidus*, Wied., *T. albimedius*, Wlk., *T. sanguinarius*, Wlk., and *T. mandarinus*, Schiner.

Tabanus rubidus, Wied.

A long series of 148 males and 171 females. The females are all of the typical blackish colour, only two specimens inclining to the reddish colour similar to that of *Tabanus albimedius*, Walker; whereas all the males are reddish in colour on the abdomen, two specimens only approaching the colour of the females. This strengthens my belief that *T. albimedius* will prove in the end to be only a form of *T. rubidus* (see my remarks in Records Indian Museum, iv, no. 6, p. 156, 1911).

Tabanus albimedius, Walker.

A series of 11 females and 2 males. There are four or five females of a darker colour, not the typical colour of *Tabanus rubidus*, which might possibly be a new species, but for the present I prefer to label them as a form of *T. albimedius*, finding no good characters to distinguish them from the typical form; they are rather larger in size.

Tabanus mandarinus, Schiner.

A very large series of 235 males and 319 females, many of them with the lateral spots extending to the fourth and fifth segments, even to the sixth, and all with broad abdomens. It appears to me doubtful whether the species can be kept separate from *Tabanus amaenus*, Walker (see my remarks on these two species in Records Indian Museum, iv, n. 6, p. 167, 1911).

Tabanus sanguineus, Walker.

Females only are present (83), at least I cannot distinguish any males as belonging to this species.

Tabanus macfarlanei, sp. nov.

Type (female) and a series of 21 others from Hong Kong.

A medium-sized blackish species with clear wings, the fore border brownish; forehead narrow; antennae reddish; legs black. Length, type 14 mm., others 12–16 mm. Distinguished from *Tabanus inobservatus*, Ricardo, by the red antennae, and from *T. perakiensis*, Ricardo, by the blackish tibiae and the wholly black beard and palpi.

Face black, covered with bronze-coloured tomentum, and with black pubescence ; beard black. *Palpi* black, fairly stout at base, ending in a short point. *Antennae* bright reddish, the first two joints duller coloured, with black pubescence, the third joint with a very small tooth, not very wide at the base. *Forehead* narrow, only half as wide anteriorly as it is at the vertex, so that it is about ten times as long as it is wide anteriorly ; frontal callus long and narrow, reaching the eyes, with a lineal extension. *Thorax* and *scutellum* blackish, with black pubescence and some appressed pale fulvous pubescence ; there are traces of plum-coloured tomentum on the anterior part of the thorax. *Abdomen* blackish, covered with very short close black pubescence, a few fulvous hairs in the middle of the first segment ; underside almost devoid of pubescence. One specimen has the abdomen of a very dull obscure reddish brown, becoming black at the apex. *Legs* black, tibiae sometimes a very dull reddish, pubescence black. *Wings* yellowish brown on the fore border, reaching the first basal cell and at the apex more widely diffused, extending into the first posterior cell, stigma blackish brown ; no appendix present.

Tabanus hongkongiensis, sp. nov.

Type (female) and a series of 63 additional females from Hong Kong.

A blackish brown species belonging to Group IX, the abdomen having clearly marked grey spots and bands. Frontal callus large, oblong, with a thick spindle-shaped extension. Antennae reddish ; palpi yellow ; legs blackish, tibiae yellowish. Length, type 15 mm., others 12–15 mm.

Face covered with ashy grey tomentum and with white hairs ; beard white. *Palpi* yellow with black hairs, large, stout, ending in an obtuse point. *Antennae* reddish, the first two joints with black pubescence, the third blackish at apex. *Forehead* slightly broader in front, about six times as long as it is broad anteriorly, a little darker in colour than the face, frontal callus blackish brown, almost reaching the eyes, oblong, the stout extension rather longer than the callus itself. *Thorax* blackish, covered with greyish tomentum ; three stripes appear anteriorly but are not continued, being represented by two grey spots on the posterior border. *Scutellum* of the same colour as the thorax. *Abdomen* reddish brown, darker in the centre, the first segment greyish at the sides, the second segment and the following three with clearly defined median grey triangular spots ; on the second and third segments appear small grey side spots, ill-defined, and reaching the posterior border, but not the anterior ; all the segments with grey posterior bands, these bands and the spots all grey tomentose, covered with pale yellow or whitish hairs, and the same coloured hairs on the sides ; underside greyish with narrow white-haired segmentations. *Legs* : femora blackish with grey tomentum, tibiae yellowish, at apices dusky, tarsi blackish, pubescence on coxae and femora white, elsewhere black. *Wings* clear, stigma yellowish.

One male specimen in bad order appears to be the male of this species, the abdomen is darker in colour. Eyes with large facets occupying two-thirds of the surface, and reaching the base of the frontal angle.

Tabanus indianus, Ric.

Thirty females.

Tabanus crassus, Wlk.

Nine males. The female of this species is as yet unknown.

Tabanus ditaeniatus, Macq.

Five females.

Tabanus flavothorax, Ric.

Three females.

Tabanus hybridus, Wied.

One female.

Tabanus negativus, Ric.

One female.

Tabanus hilaris, Wlk.

Two males and three females.

Tabanus jucundus, Wlk.

One male and twelve females.

Chrysops dispar, F.

A series of 154 females. No species of this genus had previously been recorded from Hong Kong.

Chrysops mlokosiewiczi, Big.

A series of 32 females. *C. striatus,* Wulp, is a synonym of this species.

The following species not represented in the collection have also been recorded from Hong Kong :—*Tabanus striatus,* F. (recorded as *T. sinicus,* Wlk.). *Tabanus agricola,* Wied., a species not known to me. *Tabanus amaenus,* Wlk. ; the type is a male. *Tabanus felderi,* Wulp. ; recorded under the name of *T. bucolicus,* Schiner, a male, which is probably a synonym of van der Wulp's species.

RECENT QUESTIONING OF THE TRANSMISSION OF VERRUGA BY PHLEBOTOMUS.

By Charles H. T. Townsend,

Bureau of Entomology, U.S. Department of Agriculture.

Inasmuch as *Phlebotomus verrucarum*, Towns., has been seriously questioned as the vective agent of verruga in an important memoir recently issued,* the writer feels it incumbent upon him to answer the objections raised, as well as to reply to the various speculations put forward in the same work relating to the subject of the insect transmission of the disease.

Taking the points in order of pagination, we find first that the writer's experiment XV on a hairless dog is cited by the authors of the memoir and the statement is made that eruptive papules seen by them in this dog were not verruga (pp. 155–7). By abrasion these lesions became secondarily infected and dried over, and it was this condition that the authors saw. A papule excised on 22nd August 1913 from the same area showed verruga structure on sectioning. A smear from the papule of 19th July 1913 showed "a considerable number of bodies bearing a certain resemblance to *Leishmania*, but lacking the kinetonucleus and manifestly not that organism. I have found the same type of bodies in the Phlebotomus" (quoted from the writer's article reproduced by the authors—p. 156). The bodies from the papule were apparently early schizonts of the *Bartonella*,† identified by the writer at the time with the *Leishmania*-like bodies announced by Gastiaburú and Rebagliati in 1912. The bodies of similar type from the *Phlebotomus* were probably ookinetes, a fuller study of which is planned by the writer. Especial attention is called to the subsequent history of this experiment, which is significant, *immunity having been conferred by the* Phlebotomus-*injections causing the disease.*‡

The case of Mr. Nicholson, due to *Phlebotomus* infection, is cited and attention called to the period of 39 days between the lapse of the fever and the inception of the eruption (p. 158). Note the already published statements on this case,§ including the fact that Mr. Nicholson did not enter the verruga zone during this period. Both the fever and the eruption must be traced to the *Phlebotomus* bites of 17th Sept. 1913.

The writer's experiment in McGuire is referred to (p. 159). Supplementary data on this case have recently been published.¶ The authors quote from the writer's first article: "The blood showed . . . the sparse presence of bodies which the writer identifies as *Bartonia*." These bodies, as shown in McGuire's smears, are

* Strong, Tyzzer, Sellards, Brues & Gastiaburú.—Rept. First Exp. S. Amer., Harvard Sch. Trop. Med. (Cambridge, Mass.), pp. 5–174 (1915).

† Jl. Washington Acad. Sci., v, no. 21 (1915).

‡ Jl. Econ. Ent., vii, p. 360 (1914).

§ Ent. News, xxv, no. 40, pp. 131–2 (1914).

¶ Am. Jl. Trop. Dis. Prev. Med., iii, p. 26 (1915).

well illustrated by fig. 1, Pl. VII, of the report, from a mild case of verruga. Attention is especially called to McGuire's blood smears, for *they demonstrate the* Bartonella *gametes in the erythrocytes, positively caused by the experimental bites of the* Phlebotomus *in a subject who had never entered a verruga zone.*

It is said that verruga-eruption infection may be transmitted in a similar manner to that of smallpox (p. 160). This is positively contra-indicated, not only by the hundreds of verruga cases in all stages of the eruption treated in open ward without a single new case arising therefrom, but also by the writer's recently published interpretation of the asexual cycle of the *Bartonella*,* and the latter's evident dependence upon the *Phlebotomus* for transmission.

Matucana, Peru, altitude 7,800 feet (wrongly given 7,300 in the report), situated in the dilute upper limits of the Rimac verruga zone, appears to be the only point in the infected region where any one of the authors has spent a night (p. 160). Entomological investigations in the dilute limits of the zones are obviously not greatly productive of results bearing on the transmission of the disease. Invitation extended by the writer to the authors at the time to spend one or more nights with him in Verrugas Canyon, the centre of the infected zone, was declined. Some insects were collected by the authors at Surco and San Bartolome during daylight, but no night work was done. Thus they secured no insects that have any bearing on the transmission of verruga. Not a single specimen of the *Phlebotomus* was secured by them, though it was present at Matucana during their visit.†

It is stated that the relationships of *Bartonella* indicate that it should be transmitted by a tick (pp. 171–2). It can be said positively that this is a futile idea. The writer and his assistants dragged Verrugas Canyon at various seasons with flannel cloths, through herbage and over bare rock and soil, in all kinds of situations, and not a single tick was secured in this manner. The only ticks obtained in the verruga zone were *Boophilus annulatus*, on horses and cattle; *Ixodes lagotis*, on vizcacha; *Ixodes* sp., on rats; and *Argas* sp., on *Athene* and goatsuckers. All of these species occur outside the verruga zone as well as within it. The relationships of *Bartonella* (whatever they may be, and whether rightly or wrongly interpreted by the authors) to the contrary notwithstanding, no tick can possibly be the vector of verruga. As a matter of fact, *Bartonella* does not appear to be at all closely related to the distinctively tick-borne protozoa. However, *relationship of host* counts for little in parasitism; the real requisite is *correspondence of conditions* furnished by the host.

The supposition is ventured that the mosquito, *Phalangomyia debilis*, Dyar & Knab, found at Matucana, may occur throughout the verruga zone (p. 172). There is no possibility of such being the case. The writer made collections of all the adult mosquitos that he could find in the verruga zone, both indoors and out-of-doors, by day and night, and did not meet with this species at all. The form is a very peculiar one and evidently confined to the higher region above the centres of verruga infection. Matucana is more than 2,000 feet above Verrugas Canyon.

* Jl. Washington Acad. Sci., v, no. 21 (1915).

† Peru To-day, vi, pp. 57–8 (1914); Anales de Zool. Aplicada, Santiago, Chile, i, p. 45 (1914).

Mosquitos are suggested as likely vectors of verruga (pp. 172–3). There is not the slightest possibility of the transmission of verruga by a Culicid. The authors' experiments with the above *P. debilis*, given on pages 41 and 42, which involved a great amount of work, are interesting, but of little practical moment. The writer calls attention to his already published statement that from July 1913 to February 1914 only one Culicid specimen was discovered by himself and his assistants in the house at Verrugas Canyon, and that not until 18th February.*

Finally, it is stated: "It must naturally be borne in mind that there are undoubtedly many other insects in these zones which remain to be discovered" (p. 173). This is unquestionably so, but it cuts no figure in the present investigation, for *there are no bloodsuckers occurring in any abundance to which this statement can be applied.* The vector of verruga must of necessity be a nocturnal or crepuscular bloodsucker which is abundant in individuals during the humid season, or period of greatest prevalence of the disease, and never absent at any time of the year. *It can be stated absolutely that the* Phlebotomus *is the only species that meets these requirements*, coupled with the complementary requirement of being confined to the verruga zone. Probably few will question that the present writer's personal experience of nearly two years with the bloodsucking fauna of the Rimac verruga zone should qualify him to speak authoritatively on this subject.

* Peru To-day, vi, p. 62 (1914); Anales de Zool. Aplic., i, pp. 54–6 (1914).

NOTES ON AFRICAN CHALCIDOIDEA—IV.

By James Waterston, B.D., B.Sc.,

Imperial Bureau of Entomology, London.

Timioderus, gen. nov.

♀. The entire integument of the head and body metallic and shagreened, or highly raised reticulate; the abdominal tergites being a little smoother. *Head* in profile triangular, from above somewhat thin, shallowly concave across the frons, rounded behind the eyes from vertex to genae; but medianly, behind the raised ocellar traingle, there is an inconspicuous ridge before the occiput; from in front, exceedingly wide, the scrobes set close together in the middle of the face, well above the base line of the bare eyes. Labrum long, spade-shaped, conspicuous; mandibles similar, bidentate, a little asymmetrical. *Antenna* thirteen-jointed, with simple cylindrical joints; the divisions of the club indistinct. *Thorax* much swollen; pronotum almost concealed behind the head; nearly separated into two tergites; prosternum posteriorly truncated, triangular; mesonotum with the parapsidal furrows fine and hardly traceable. Axillae quadrate, touching, or only separated narrowly (?). Scutellum with a transverse suture before the unarmed, rounded apex; mesopleural femoral furrow well-marked, and the prepectus rather large. *Wings*: forewings with the post-marginal almost obsolete; radius very short, with a terminal group of clear cells instead of the usual linear arrangement. Hind wings with the submarginal cell long and wide. *Legs*: fore coxae long; hind tibiae bicalcarate without apical comb. *Abdomen* sessile or practically so; broad, depressed and broadly concave above; very shortly carinate (basal one-third) below. The first tergite (which with ii. and iii. is posteriorly, medianly notched), covers three-fourths of the surface; tergite ii. reaches the edge; the third is on the edge; while tergites iv., v., vi., vii. are all *ventral* in position. The ovipositor is broad, stout, with strong teeth on the needles and central piece.

Timioderus refringens, sp. nov. (figs. 1, 2, 3).

♀. A dark metallic blue or emerald green species, refringent on every part of head, thorax and abdomen. The ground colour of head and thorax is blue overlaid with green or bronzy green. The purest blue appears on a broad central line on the mid lobe of the mesonotum, and again on the apex of the scutellum beyond the suture. Antennae dull black, the scape browner and paler beneath. All the coxae are blackish brown, except on outer aspect, where the metallic tints of the thorax are reproduced; all femora blackish brown, non-metallic to about one-sixth before the apex, the apices of tibiae and tarsi pale; the tarsi are slightly infuscated towards the apex and the claws are blackish brown.

Head (fig. 1, *e*) nearly twice as broad as deep (17 : 9). The distance between the orbits across the middle of the face over four times an eye diameter. Scrobes almost circular; exactly in the middle of the face, and separated by less than the diameter of either. Distance between the lateral ocelli over one-third of that between the eyes across the vertex. Post-scapal depression broad and shallow, with no definite margins. Below the scrobes and above the mouth-edge the face is somewhat raised ;

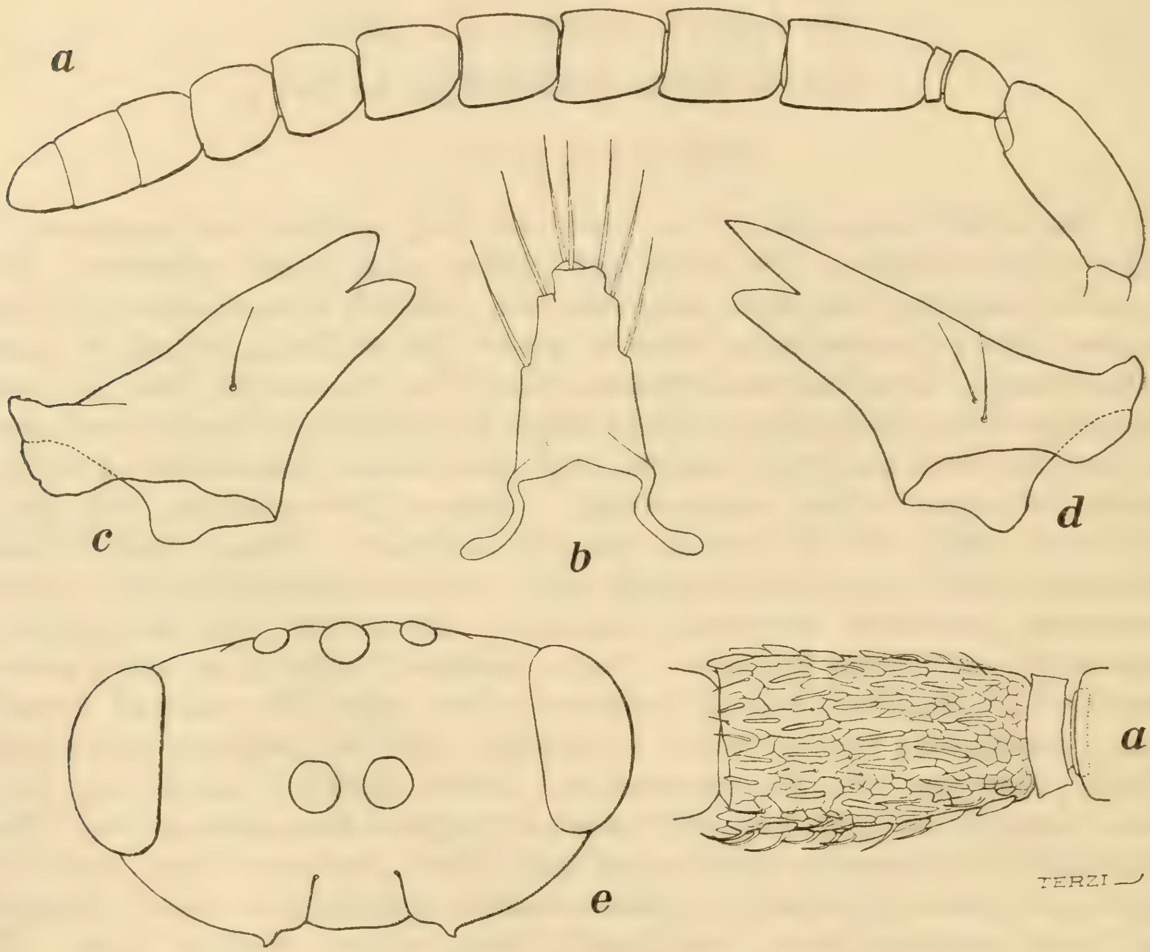

Fig. 1. *Timioderus refringens*, gen. et sp. n., ♀ ; *a*, antenna, and enlargement of ring joint and first funicular ; *b*, labrum ; *c*, right mandible ; *d*, left mandible ; *e*, head from in front.

on this area (as well as on the occiput) the sculpturing tends to form concentric striae and rugae, elsewhere it consists of highly raised coarse reticulations. Mouth-edge concave ; twice slightly sinuate at the sides, and with middle broadly and gently convex. *Antennae* (fig. 1, *a*) : length, 1·9 mm. ; scape short and broad (7 : 3) ; pedicel (2 : 3) two-sevenths of the scape ; funicle, 20, 16, 14, 13, 13, 12, 12 ; club (indistinctly septate) 8, 11, 9 ; breadth of both, in the same ratio, 12. The sensoria on the funicle and club are very numerous. In some the blade is free, in others almost entirely adherent. *Mouth-parts* : labrum (fig. 1, *b*) long, truncate, with apically convergent sides, and bearing the spiny bristles figured. Mandibles (fig. 1, *c*, *d*) stout, narrow, the teeth on the right one subequal, broad, though pointed ; the lower tooth of the left acute.

Thorax (fig. 2, *a*): the strongly sculptured integument shows a fairly regular pattern on back and sides. The lateral suture between the axillae and side lobe of mesonotum forms a smooth wedge. There are traces of transverse rugae across the femoral impressions on the mesopleurae, and the mesosternum is medianly almost smooth; but the parapsidal and axillary sutures are very fine, and only

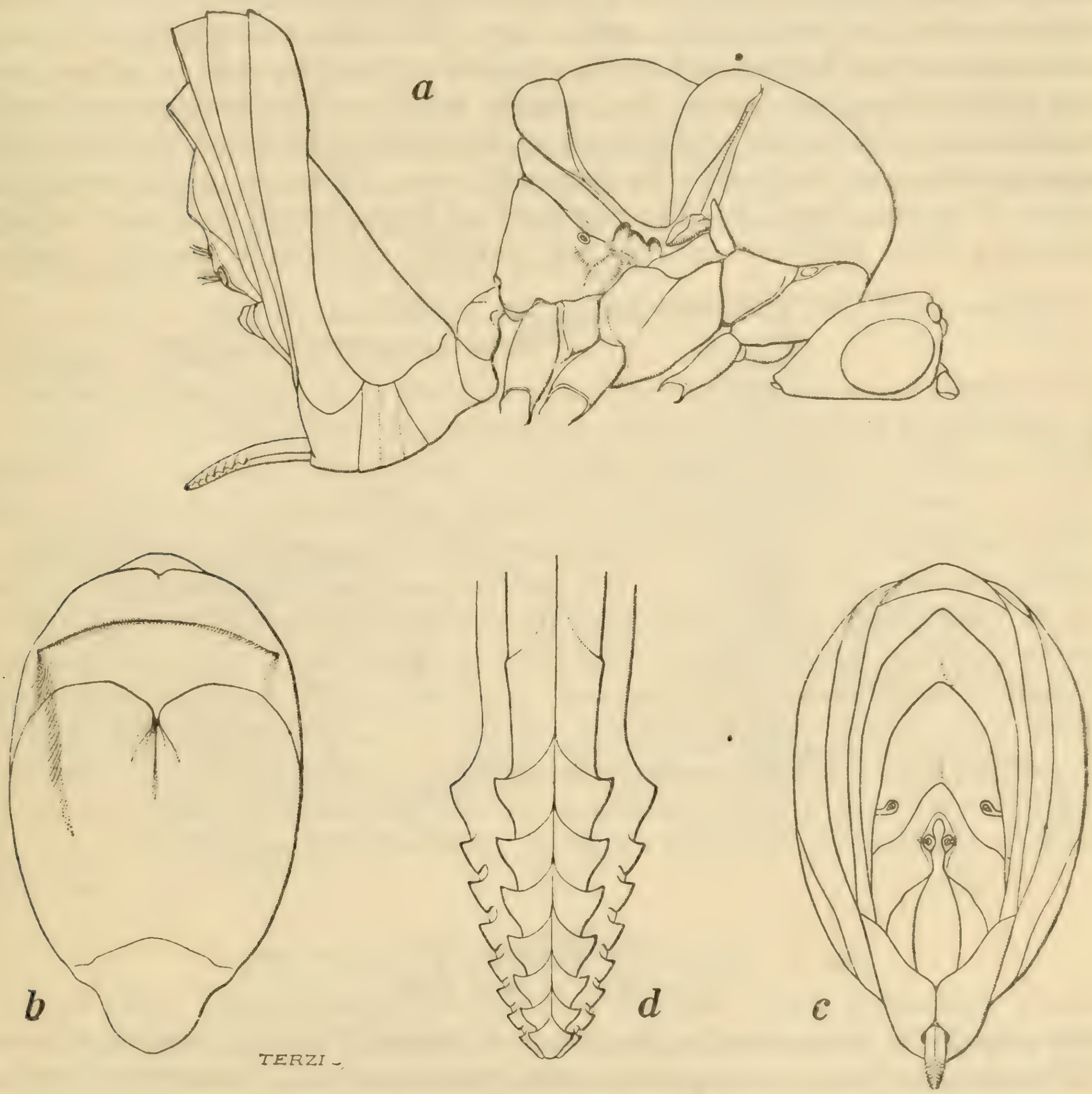

Fig. 2. *Timioderus refringens*, ♀; *a*, body, side view; *b*, abdomen from above; *c*, abdomen from below; *d*, ovipositor.

partially decipherable. Directly from above the protergites are invisible. The mesonotum before the suture is heart-shaped; the parapsides are distinctly invaded by the quadrate axillae. The scutellum is long, two-thirds of the mid lobe, overhanging the propodeon, but rounded and not developed into a process. The propodeal spiracle is small, circular, and placed far down on the pleurae, and anteriorly facing the metanotum.

Metathorax medianly rounded and sculptured like the notum of the mesothorax; the side-pieces are rather deeply sunk and transversely ridged, but without any boundary between them and the central piece.

Fore wings (fig. 3, *a*) almost triangular, over two and a quarter times as long as broad. Length, 3·8 mm.; breadth, 1·6 mm. Submarginal : marginal : radius : post-marginal, as 16 : 7 : 1 : 1. Pubescence of the wing fine and dense to below the marginal vein. Basal triangle and a narrow tapered space along the hind margin (ending before the level of the radius) bare. The long submarginal cell bears numerous short fine bristles, and on the marginal vein are two more or less complete rows of feeble fugacious bristles; the marginal, radius and post-marginal are densely set with short stiff bristles. Both marginal and radial veins broad, the latter with a group of eleven to twelve pustules terminally, none of them projecting beyond the margin of the vein (fig. 3, *b*). The post-marginal is represented by a short, tapered thickening with indistinct outline, but certainly not longer than the radius.

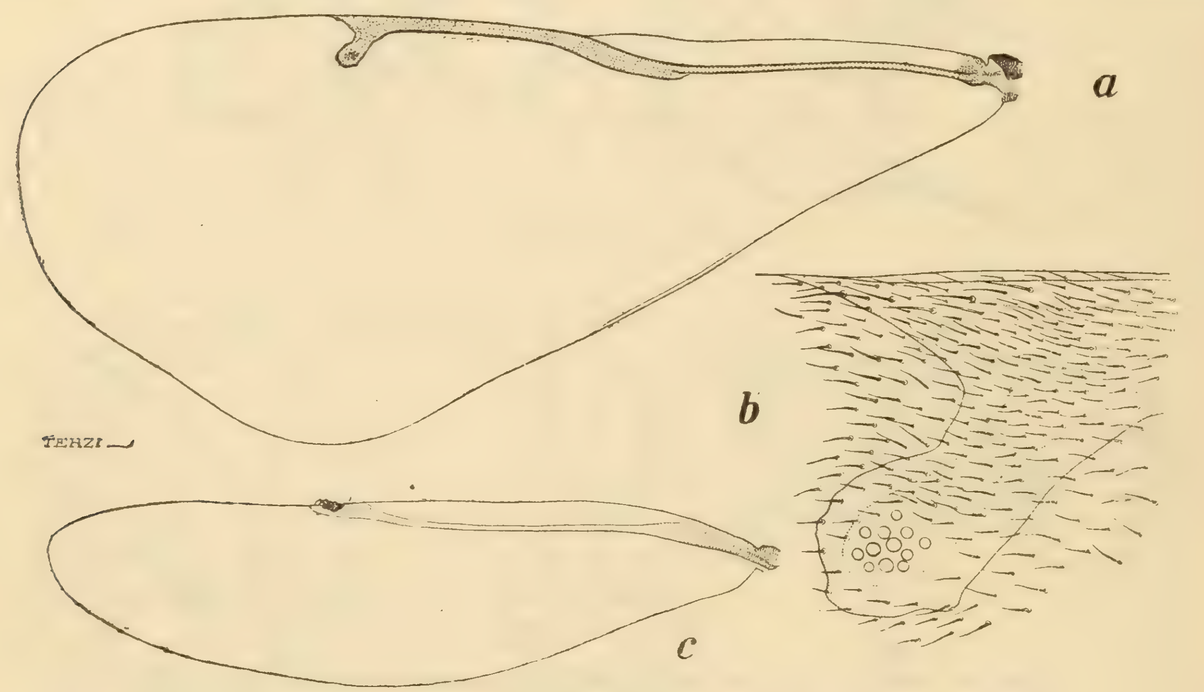

Fig. 3. *Timioderus refringens*, ♀; *a*, fore wing; *b*, radius; *c*, hind wing.

Hind wing (fig. 3, *c*) four times as long as broad; length, 2·8 mm.; breadth, 0·7 mm. The submarginal cell extending to the hooks, pubescent, except narrowly in front of the vein. But for a bare line at the apex, the wing is otherwise evenly pubescent. The frenulum consists of six curved hooks, arching over a patch of short spinose bristles, arranged in three rows of about ten each.

Legs: the outer surface of all the coxae coarsely raised reticulate, like the thorax, etc.; the inner surface smooth and clad with silvery pubescence towards the apex. The legs are otherwise smooth and pubescent. All the tarsal joints bear apically on the plantar aspect several strong stiff hyaline bristles. Above the insertion of the tibial spurs are 2–3 spines, but neither on the anterior nor on the posterior legs is there any complete transverse row. Similarly, the comb of the first tarsal joint is wanting, though all the bristles on the anterior aspect are thickened and spinose.

The fore femora are somewhat thickened and broadest near the base. In all the tarsi, from the third to the fifth joints (including claw) the proportions are the same, viz. :—4, 3, 11. In all the legs, the first tarsal joint is twice the second. In the fore tarsus, the first joint is one-fifth longer than in the mid or hind tarsi.

Propodeon triangular, truncate, with a slight median keel.

Abdomen sessile, but so narrowed at its insertion as to appear petiolate in side view ; abruptly broadened, truncate, in general shape triangular, rounded postero-laterally. The tergites cover all the upper and three-fourths of the under surface as well. All the tergites, especially the first, are posteriorly incised in the middle, and this shows clearly on tergites i. and ii., but on iv. to vii., owing to infolding, the posterior margin of each tergite forms a pointed arch (fig. 2, *c*). Sixth tergite medianly carinate. Spiracle lateral in position, circular, with a narrow outwardly pointing sulcus. Seventh tergite not carinate. The stylets are nearly touching.

Length, about 5 mm. ; alar expanse, over 9 mm.

NYASALAND : Lake Nyasa, Monkey Bay, 3 ♀♀, 1.vi. 1915 (*Dr. W. A. Lamborn*).

Type, a ♀ in the British Museum.

Besides the above there is, in the collection of the Imperial Bureau of Entomology, a complete ♂ labelled Mlanje, Nyasaland, 15.xi.1913, and another fragmentary ♂ (thorax and wings) also from Mlanje, 13.xi.1913, taken by Mr. S. A. Neave, while being preyed upon by an Asilid fly, *Promachus fasciatus*, F., in both cases.

I believe these to be the ♂ of the species described above. In sculpturing the Monkey Bay and Mlanje specimens agree. The ♂♂, however, are generally bluer all over, the abdomen is more distinctly petiolate, and the size slightly less. In the antennae, the scape is practically as dark below as the funicle and club, whose segments are distinct. But, apart from these purely sexual differences, there is evidently nothing to add to the generic definition already given. The genus *Timioderus* has the general facies of those Eucharines which are distinguished by the entirely unarmed scutellum, but the mandibles are of a type very different from that generally found in this family, so that a Perilampine relationship is more probable.

Genus SPILOCHALCIS.

Of this genus, so numerously represented in the New World, particularly Brazil, few species have been described from the Eastern Hemisphere. Excluding the genotype *S. xanthostigma*, Dalm. (1820), from Europe, I know of only three Old World forms ; *S. nigrorufa*, Walk. (1853), (described as a *Smicra*), from India ; *S. capensis*, Cam. (1907), from the Cape ; and *S. libanotica*, Schmied. (1909), from Asia Minor. Probably *Chalcis pensilis*, Klug (1834), from Egypt, should be placed here. From all these, *S. andersoni*, sp. n., may be separated at once by the entirely orange propodeon. In the longer American series such a propodeon is apparently not uncommon ; *e.g.*, in *S. erythrina*, Walk. (1861), Mexico, and *S. igneoides*, Kirb. (1883), North America. In the American fauna, however, the yellow and black species greatly preponderate. But of the six Old World forms mentioned here, five are red and black. In *S. andersoni* the basal tooth of the hind femur is remarkably small.

Spilochalcis andersoni, sp. nov. (fig. 4).

An orange red species with black markings.

♂. Antennae blackish brown, the scape paler on the ventral edge. Frons, genae and occiput, at the sides, orange, post-scapal and ocellar areas and the mid occiput black. Mandibles orange-yellow, with the teeth brown. Thorax, abdomen and legs orange, with the following marks :—a broad, median black band extending over all the notum of the thorax, occupying about one-third of the pronotum, and widest anteriorly on the mid lobe of the mesonotum, on which sclerite it is medianly contracted ; it covers the suture, but does not invade the side lobes or axillae ; after the suture it contracts, and only expands again narrowly above the metathorax. The mesosternum is extensively brownish, and the prosternum less so ; the lower two-thirds of the mesopleural femoral furrow, and a spot above the insertion of the

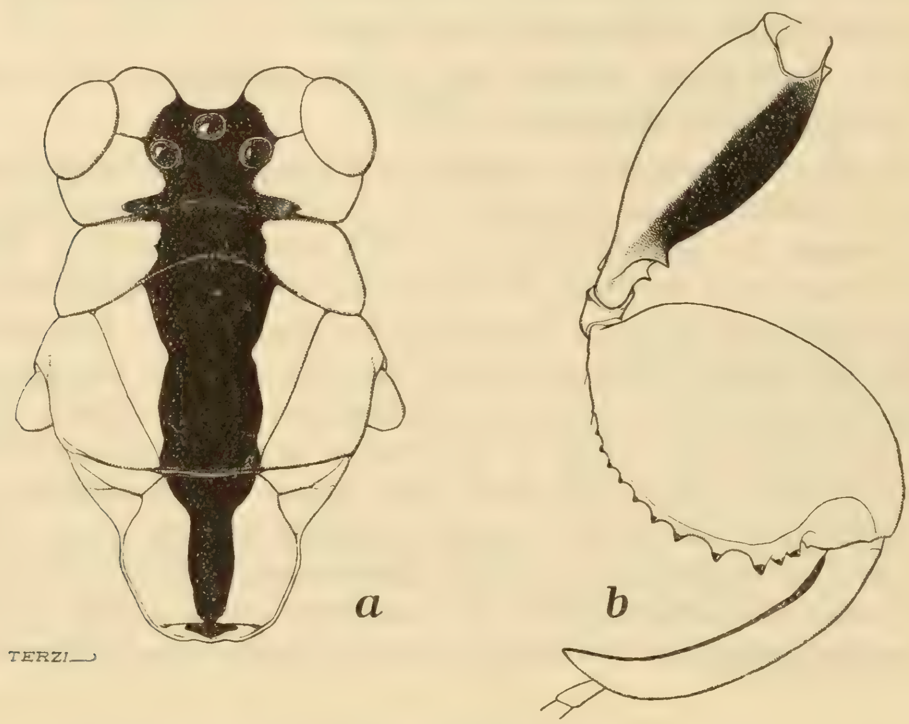

Fig. 4. *Spilochalcis andersoni*, sp. n. ; *a*, head and thorax ; *b*, hind coxa, femur and tibia.

hind coxa, blackish brown. A faint spot outside the fore coxae, the mid coxae entirely, and the hind coxae above, together with the trochanters, brown or blackish brown ; teeth of the hind femora and inner superior edge of the tibia, narrowly black ; all the tarsi are a little darker apically, and the fore and mid tarsi, together with the tips of the tibiae, are yellowish red. The ground colour of the abdomen is seen principally on the petiole and basal half ; towards the end it becomes infuscated. Wings, especially the subcostal cell, and below the marginal, a little brown ; the veins brownish black. The general colour of the body pubescence is tawny or orange.

Head : breadth to depth as 7 : 5 (vertex to clypeal edge) or 7 : 6 (to apex of closed mandibles) ; across the face, three times the diameter of an eye. Clypeus and labrum straight, the latter with eight or nine bristles. Genae shining, finely striate ; malar

keel delicate, at first descending almost perpendicularly to below one-half, and then curving forward to the corner of the mouth. Above the clypeus the surface is a little shining, finely striate or reticulate ; impunctate near the mouth, but with many shallow setigerous depressions towards the scrobes. At the sides of the frons and on the vertex the puncturation is deeper and more even.

Thorax: the entire thoracic notum, except the apex of the scutellum and overlapping parts of the pronotum, show a thimble-like puncturation ; the punctures generally equal and evenly disposed ; those on the axillae the smallest, while the largest occur antero-medianly on the mid lobe ; between the punctures, the surface is very finely striate, rugose, or reticulate. Scutellum with a fine median furrow dying out at about one-half ; vertical aspect of apex smooth ; plate above metanotum with three flatly rounded, shallowly separated lobes : the median smallest. The sides of the pronotum are finely raised striate ; mesepisternum smooth, shining ; mesepimeron on the lower half, with one or two rows of large punctures with ridges between, but smooth above. Metapleurae rounded, swollen, with large, regularly disposed punctures.

Wings : length, 5 mm. ; breadth over 1·75 mm. Submarginal : marginal : radius : post-marginal, in the ratio 16 : 5 : 3 : 6.

Hind legs : the coxa seven-eighths of the femur, which is greatly swollen (16 : 11), both shining, with minute. scattered punctures ; the femur with eleven teeth ; the basal very small and the five succeeding increasing in size ; seven and eight larger, equal, and three in a clump at the apex.

Propodeon with a strong, median keel, bifurcating posteriorly at about one-half ; within the forks are six cells (3, 3), round and above the petiole. The mid cell on each side is largest, and receives the irregular notopleural edge, between which and the central keel are five large, and two or three (anterior) small cells, and there are about eight cells on the pleurae behind the metapleurae. The spiracle, lying anteriorly behind the metapleurae, narrow, with straight inner, and broadly emarginate outer edge, is placed vertically and faces posteriorly.

Abdomen, including petiole (5 : 2), smooth, shining ; the tergites with simple margins ; the first covering two-thirds of the disk.

Length, 5.25 mm. ; alar expanse nearly 12 mm.

Brit. East Africa : Masai Reserve, 21.iv.1913 (*T. J. Anderson*).

Type, a ♂ in the British Museum.

Hockeria munda, sp. nov.*

♀. Head, thorax and abdomen shining black, the abdominal tergites on the lower parts of their overlap, together with sternites iv. and v. and the junction of the sheath of the ovipositor with tergite vii., brown or reddish brown. Antennae castaneous on the scape and progressively darker towards the blackish club ; with the junctions of the joints appearing as darker rings. Wings hyaline ; fore coxae black ; tegulae, mid and hind coxae, and all the legs brown, the anterior pairs brighter and more castaneous, the hind legs duller and with the tibiae somewhat infuscated. Pubescence everywhere brilliant silvery white.

* See figs. 1 and 2, pp. 382 and 383.

Head narrow and compressed, very wide (about 5 : 4), eyes separated by two diameters on the vertex ; rather small, their base line cutting mid line at one-half. Frons not deeply excavated, hardly more than gently concave, as seen from above; post-scapal bare area narrow, facial and genal bristles longer towards the mouth-edge.

Antennae : length 3·4 mm. ; very long and slender ; scape swollen on basal half and narrow, with subparallel sides distally, except at the expanded apex ; about sixteen times as long as broad ; pedicel a little over one-third of the scape, with the breadth between one-fourth and one-sixth of the length ; very much longer than the second funicular (first after the normally developed ring joint), after which the antenna is a little expanded. Club narrower than the last funicular joint. Proportions after the scape :—34, 22, 20, 19, 18, 17, 16, 16, 16, and club, 22 (7 : 5 : 10). In the same ratio the breadth for the first four joints enumerated increases from 6 to 9. The succeeding four have a thickness of 10, which on the last funicular and club decreases to 8. There are four sensoria on the second funicular joint.

Thorax : all the sutures deep, with the areas delimited by them slightly swollen ; punctures large (and therefore fewer than in *Stomatoceras*), each with a strong, somewhat flattened, longish bristle; integument between the punctures smooth. Pronotum rather long, anteriorly rounded, with the usual anterior ridge indicated only at the sides. Scutellum bidentate, narrow, shorter than mid lobe and pronotum combined, without sulcus, and so overhanging the propodeon that its broad approximated teeth are in line with the posterior teeth of the latter. Metapleurae entirely covered with stiff bristles, of which there are a few in front of the bare mid femoral impression ; the latter with seven to eight transverse rugae.

Propodeon with two well-defined angles on each side behind the spiracle ; the first narrow, the second broad, both a little upturned. At the middle of each of the inner ridges from the petiole to the spiracle there is a low upward projection ; between the inner and the notopleural ridges are 8–6 quadrate cells. The large median cell, twice transversely divided, is flanked by two outer cells with similar divisions, and between these again and the inner ridge are 6–7 cells, of which that behind the median projection of the ridge is much the largest. The metapleura are swollen, and there are no well-defined lateral patches of bristles flanking the insertion of the petiole.

Fore wings over two and a half times as long as broad ; length, 3·15 mm. ; breadth, 1·15 mm. Submarginal : marginal : radius, as 26 : 5 : 1. There are only about twelve bristles on the long submarginal, below which, until near the uprise, the wing is quite bare ; on the marginal (after the pustules) and radius combined there are twenty to twenty-three bristles, stouter and a little longer than any found elsewhere. The rest of the wing is evenly covered with similar short bristles which are slightly longer near the marginal. The bare longitudinal line occurring in most Haltichellines just below one-half is clearly indicated, but there are no scales anywhere. *Hind wings* : length, 2·3 mm. ; breadth, 0·65 mm. Near the base the submarginal comes close to the costa, and here there are about twenty-five closely-set short bristles, and many more on the vein itself ; there are about nine minute bristles in the frenulum.

Hind legs : femur much swollen ; behind the major tooth are forty-nine denticles ; apical tibial comb or fringe of over forty long bristles.

Abdomen narrow and long pointed, only three-quarters as broad as the thorax. First tergite short, its posterior margin cutting a line from the stylets to the petiole at one-third; second tergite markedly biconcave, one-third as long as the first; third tergite about one-half of the first; fourth tergite like the second; fifth and sixth a little shorter. The dorsal surface of the abdomen as a whole very smooth; 7–8 stiff bristles from punctures at the side of tergite i.; on tergite ii., the overlaps bear numerous similar bristles in 5–6 rows; tergites iii. and iv. have each one row, and tergite v. two rows; tergite vi. is basally bare, but with the distal two-thirds closely set with bristles. The projecting part of the sheath is shorter than the ridge on tergite vii.

Length, 5½ mm.; alar expanse, 8 mm.

NYASALAND: Lake Nyasa, Monkey Bay, 27.v.15 (*Dr. W. A. Lamborn*).

Type, a ♀ in the British Museum.

Through the courtesy of the Curator of the Albany Museum (Mr. J. Hewitt) I have been able to examine the type of *Hockeria melanaria*, Cam. (Rec. Albany Mus., i, p. 314, 1905). This species, which is correctly placed, may be told at once from *H. munda* by the legs, which are entirely black, except on the knees, and obscurely on the last tarsal joints. The mid femoral pleural impression in *H. melanaria* bears about fourteen fine ridges.

Ooencyrtus lamborni, sp. nov. (figs. 5, 6).

♀. Head, prothorax, mesonotum and pleurae shining, blackish; the scutellum concolorous with the rest of the thorax, but dull, except at the tip, though somewhat refringent when highly magnified and in strong sunlight. Apex of scutellum shining,

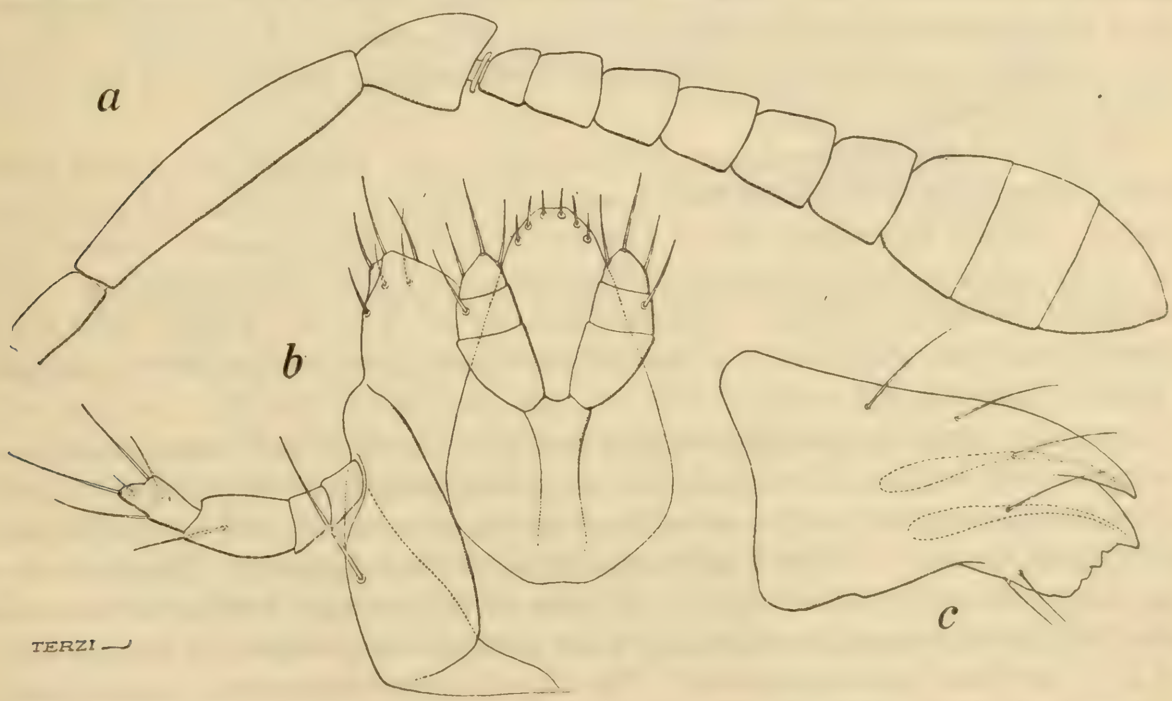

Fig. 5. *Ooencyrtus lamborni*, sp. n., ♀; *a*, antenna; *b*, trophi; *c*, mandible.

blue-black; there is a trace of the same colour in the reflections of the malar space. Propodeon blackish brown; the abdomen lighter, pale. Wings hyaline; nervures light brown. Legs and antennae pale, the funicle a little smoky.

Head as broad as deep ; eyes with extremely short but regular pubescence ; not so approximated as in *O. pacificus* ;* separated by more than an eye diameter, or rather more than one-third of the greatest width of the head. Base line of the eyes two and a quarter times the distance across the vertex. Scrobes triangular, but not so narrow as in *pacificus*, and drawn out transversely, not vertically as in that species ; clypeal edge medianly straight. Pattern more distinct than in *pacificus*, but not strong enough to cause any dulness. The rows of bristles between the scrobes are divergent towards the mouth, and there are three or four bristles at each side before the genal ridge.

Antennae (fig. 5, *a*) : scape narrow, with subparallel sides. Pedicel stout and short (three-eighths of the scape) ; barely longer than deep. Funicle : 5, 7, 8, 9, 10, 10—all the joints transverse. Club : 1, 1, 1,—much swollen ; about twice as broad as the last or four times the first funicular joint. Length of antenna, 0·35 mm.

Mouth-parts (fig. 5, *b*) : labrum straight-edged ; maxillary palpus, 4, 4, 6, 4 ; the second segment widest and the fourth narrowest ; one bristle on the third, and four on the fourth segments respectively. Labial palpus : 5, 2, 3. *Mandible* (fig. 5, *c*) with an outer tooth, stout and deeply cleft from an inner, above and within which the apex of the mandible is straight (minutely, feeebly denticulate, under one-sixth objective, with no. 4 eyepiece). The apical and upper edges meet in rather over a right angle.

Thorax : the pattern on the pronotum is coarse, and there is no alternating row of weaker bristles before the usual posterior row ; the mesonotal pattern coarse, but not appreciably raised ; on the scutellum, however, the reticulation is both coarse and raised ; less so on the axillae. There are fewer bristles all over than in *pacificus* ; about thirty before the suture, two to three on the axillae, and eleven to twelve on the scutellum ; on the pleurae the pattern is distinct and practically all the sternal surface is reticulate.

Fore wings (7 : 3) broader than in *pacificus* (fig. 6, *a*) ; marginal vein a mere point. Radius long, (fig. 6, *b*) with one bristle and a distinct bare area from in front to well behind. Behind the hairless line is a patch of about a dozen minute bristles ; the rest of the basal triangle being bare, except for a row below the submarginal. Submarginal : marginal : radius : postmarginal, as 20 : 1 : 3 : 2. Length, 0·63 mm. ; breadth, 0·27 mm. *Hind wings* : the marginal bears three bristles above. Length, 0·4 mm. ; breadth, 0·1 mm.

Legs : the tarsal proportions are practically as in *pacificus* ; coxae more bare, fore coxa with bristles, 2–3 apical, 2–3 along anterior edge, 8–9 external, and one above coxa on inside ; mid coxae with about the same number of external bristles as in the fore coxae. Tibiae hardly expanded ; sides subparallel. Tarsal teeth or peg-like spines less numerous (fig. 6, *c*). One or two stronger bristles at the upper apical angle of the tarsal joints and only a few scattered on the surface of the fifth joint, not as in *pacificus*, with regular rows. The claws are more robust than in *pacificus*.

Propodeon : both sides smooth with one or two rugae behind the spiracle.

Abdomen : the transverse bands on the tergites are continuous, and not pale medianly as in *pacificus* ; while behind the stylets, there is one row of bristles less.

* Bull. Ent. Res., vi, p. 307, 1915.

Ovipositor with the free portion of the sheath long, narrow, three-sevenths of the base, with five ventral hairs from one-third to the apex, and about the same number on the sides.

Length, 0·6 mm.; alar expanse, 1·4 mm.

♂. Like the ♀, with darker antennae, and the abdominal tergites almost as dark as the propodeon; near the base, the abdomen is paler.

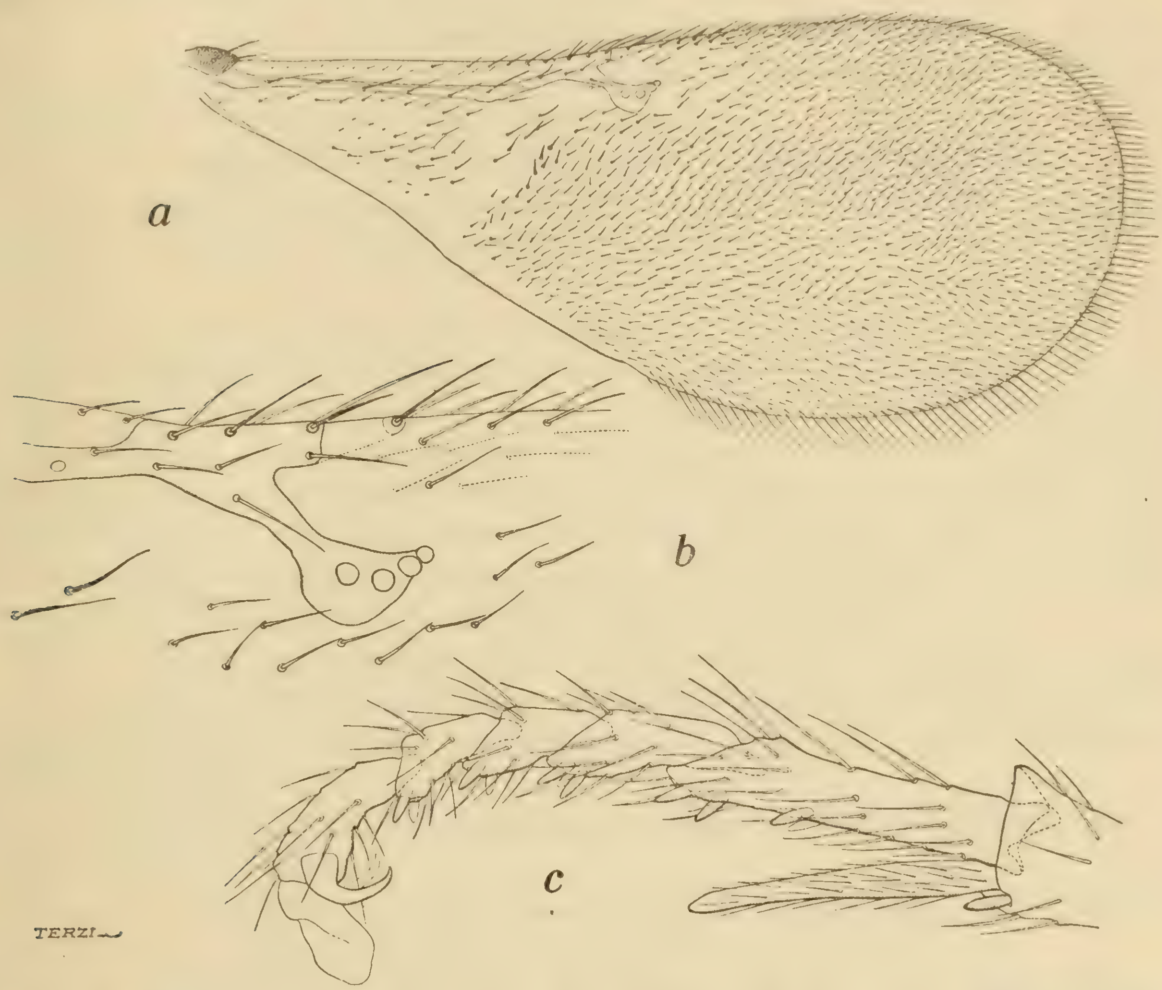

Fig. 6. *Ooencyrtus lamborni*, sp. n., ♀; *a*, right wing; *b*, radius; *c*, right mid tarsus.

Antennae: length, 0·5 mm. Scape (5 : 1) narrow; pedicel (3 : 2) one-third of scape, stouter; funicle cylindrical, the joints subequal; 1 being the shortest. The club is about twice as long as the last funicular joint and only a little wider. Thorax with one or two additional bristles on the mid lobe and scutellum, the sculpture being coarse as in the ♀. Dimensions much as in the ♀, the expanse nearly 1·5 mm. As the abdomen is generally telescoped and somewhat shrivelled in small Encyrtids, the apparent length of the species varies greatly. In *O. lamborni* there is a range of from 0·56 mm. (dry mount) to 0·72 mm. (mount in balsam after potashing), but the expanse is much more constant.

NYASALAND: Lake Nyasa, Monkey Bay, 12.v.1915 (*Dr. W. A. Lamborn*).

Type, a ♀ in the British Museum.

One of a series of 6 ♂♂ and 11 ♀♀, bred from eggs of a Pierine butterfly (*Belenois severina*, Cram.).

COLLECTIONS RECEIVED.

The thanks of the Imperial Bureau of Entomology are due to the following gentlemen, who have kindly presented collections of insects (received between 1st July and 30th September, 1915) :—

Mr. T. J. Anderson, Government Entomologist :—1 Asilid and its prey, 3 Hippoboscidae, 239 other Diptera, 256 Hymenoptera, 4 Coleoptera, 3 Rhynchota, and 5 Orthoptera ; from British East Africa.

Dr. J. H. Ashworth :—6 Chalcids and 4 larvae ; from New South Wales.

Mr. E. Ballard, Government Entomologist :—about 100 Cecidomyidae, 1 *Haematopota*, 2 Trypetidae, 21 Hymenoptera, 31 Coleoptera, and 1 bottle of Thrips ; from South India.

Dr. F. J. A. Beringer, W.A.M.S. :—3 Culicidae, about 28 Culicid larvae, 15 *Tabanus*, 3 *Glossina*, about 40 Siphonaptera, 2 Ticks, and 1 Spider ; from Sierra Leone.

Mr. G. E. Bodkin, Government Economic Biologist :—9 Culicidae, 10 Tabanidae, 5 other Diptera, 82 Ants and 67 other Hymenoptera, 32 Coccinellidae preying upon Coccidae, 32 other Coleoptera, 19 Lepidoptera, 50 Termites, 3 Ascalaphidae, about 130 Mallophaga, 1 tube of Anoplura, 27 Coccidae, 14 other Rhynchota, 2 Odonata, 13 Orthoptera, 5 examples of Insects attacked by Fungous parasites, 11 Spiders, 1 Scorpion, 1 Millipede, and 1 Woodlouse ; from British Guiana.

The Director of Agriculture, Southern Provinces, Nigeria :—3 species of Coccidae.

The Division of Entomology, Pretoria :—4 Hippoboscidae, 27 other Diptera, 13 Hymenoptera, 49 Lepidoptera, 141 Coleoptera, 68 Rhynchota, and 21 Orthoptera ; from the Transvaal.

Mr. C. M. Dobbs, District Commissioner :—1 Mayfly (*Oligoneura dobbsi*, Eaton) ; from British East Africa.

Dr. R. E. Drake-Brockman :—2 Culicidae and 3 Fleas (*Ischnopsylla brockmani*, Rothschild, sp. nov.) ; from British Somaliland.

Mr. P. R. Dupont, Curator of the Botanic Station :—36 Bostrychidae, 3 Curculionidae, 157 Scolytidae, and 100 larvae ; from the Seychelles.

The Government of the French Republic :—455 Culicidae, and about 200 larvae ; from Annam, New Hebrides, New Caledonia and Tahiti.

Mr. Walter W. Froggatt, Government Entomologist :—18 Sheep maggot flies, and 7 Chalcidoid parasites ; from New South Wales.

Dr. Lewis H. Gough, Government Entomologist :—4 *Sarcophaga* and 4 *Stomatorrhina*, parasitic on locusts, and 12 Ticks ; from Egypt.

Mr. Percy H. Grimshaw :—32 Diptera ; from Scotland.

Dr. C. Gordon Hewitt, Dominion Entomologist :—1 Moth, a pest of cabbages ; from Newfoundland.

Mr. Gerald F. Hill, Government Entomologist :—10 Diptera, 2 Ants, and their Ichneumon parasites, about 320 other Ants, 10 other Hymenoptera, 1 Staphylinid Beetle, 433 named Termites, 5 lots of Coccidae, and 5 Orthoptera ; from the Northern Territory of Australia.

Mr. E. Hutchins, Chief Veterinary Officer :—97 *Haematopota* ; from Uganda.

The Director of the Imperial Institute :—3 Coleopterous larvae ; from Fernando Po.

Mr. Rupert W. Jack, Government Entomologist :—27 Hymenoptera, 15 Coleoptera, 8 Lepidoptera, and 2 Orthoptera ; from Southern Rhodesia.

Mr. Edmund Jarvis, Entomologist :—3 Micro-Lepidoptera, attacking sugar-canes and bananas ; from Queensland.

Mr. A. W. Jobbins-Pomeroy, Government Entomologist :—8 Diptera, 2 Coleoptera, and 24 Lepidoptera ; from the Southern Provinces, Nigeria.

Dr. W. A. Lamborn :—20 *Glossina morsitans* puparia, 11 Bombyliidae and 8 puparia, 7 other Diptera, 5 Mutillidae, and 20 Chalcidoidea, parasitic on *Glossina morsitans*, 33 other Hymenoptera, 119 Lepidoptera and 31 pupae, and 8 Cockroaches ; from Nyasaland.

Dr. R. E. McConnell, M.O. :—16 Culicidae ; from Uganda.

Dr. R. Stewart MacDougall :—14 Diptera ; from Scotland.

Dr. Harold Macfarlane, Government Bacteriologist :—5,676 Culicidae ; from Hong Kong.

Dr. J. W. Scott Macfie, W.A.M.S. :—269 Culicidae, about 70 eggs, about 40 larvae, and 3 pupae of Culicidae, 40 *Glossina*, 1 *Cordylobia*, 12 other Diptera, 255 Siphonaptera, about 25 Anoplura, 3 Mallophaga, 6 Rhynchota, 5 *Hemimerus*, 46 Ticks, 1 Pseudo-scorpion, and 10 Crustacea ; from the Southern Provinces, Nigeria.

Mr. C. Mason, Government Entomologist :—6 Trypetidae, 12 Sawflies, 10 Hymenopterous parasites of Lepidoptera, 49 Lepidoptera ; from Nyasaland.

Lieut. G. St. J. Orde-Browne, Assistant District Commissioner :—1 *Haematopota*, 27 other Diptera, 12 Hymenoptera, 28 Coleoptera, 1 Moth, 52 Rhynchota, 2 Planipennia, and 7 Orthoptera ; from British East Africa.

Mr. T. Petch, Acting Entomologist :—115 Diptera, 8 Ants, 6 other Hymenoptera, 12 Coleoptera, 1 Capsid Bug, and 3 Spiders ; from Ceylon.

Dr. J. Schwetz :—157 *Pangonia* ; from the Belgian Congo.

Mr. F. W. Urich, Government Entomologist :—30 Chalcidoidea, 54 Coleoptera, and 1 species of Coccidae ; from Trinidad.

Mr. Robert Veitch :—4 Culicidae, 8 other Diptera, 3 Chalcidoidea, 10 other Hymenoptera, 97 Coleoptera, 4 Lepidoptera, 2 lots of Coccidae, 1 Ant-lion, 1 Chrysopid, 1 Centipede ; from the Fiji Islands.

The Wellcome Bureau of Scientific Research :—5 Tabanidae, 233 other Diptera, 3 Lepidoptera, 15 Hymenoptera, 9 Coleoptera, 4 Rhynchota, 1 Stone-fly, and 1 Spider ; from Colombia.

Title, Contents, Indices to Vol. VI.

BULLETIN OF ENTOMOLOGICAL RESEARCH

ISSUED BY THE IMPERIAL
BUREAU OF ENTOMOLOGY:

EDITOR: THE DIRECTOR:

LONDON:

SOLD BY
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